RAILWAY

Mechanical and Electrical Engineer

NOVEMBER,
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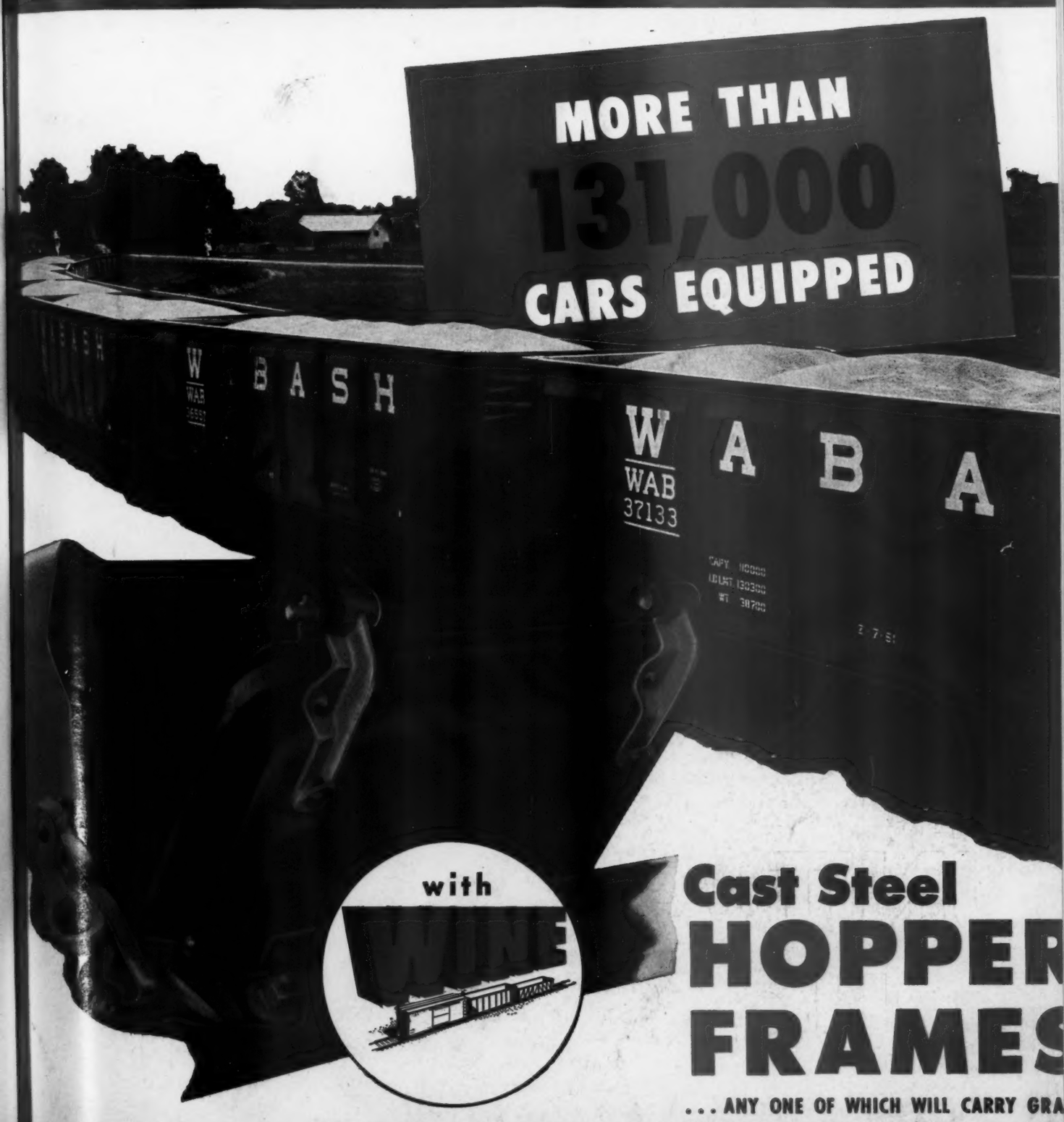

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NOVEMBER, 1950

RAILWAY Mechanical and Electrical Engineer

Founded in 1832 as the American Rail-Road Journal.

VOLUME 124 NO. 11

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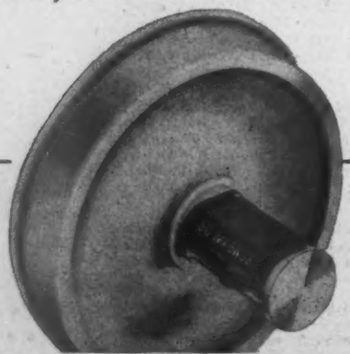

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Convention Notes

One Electrical Section

Back in 1900 a little body of men banded together and called themselves the Association of Car Lighting Engineers. Later, they decided to take in more territory and changed their name to the Association of Railway Electrical Engineers. In 1937 they acquired official status as the Electrical Section, Mechanical Division, A.A.R.

Another electrical body, known as the Committee on Electricity of the American Railway Engineering and Maintenance of Way Association, came into being in 1908. After passing through several designations, it became, in 1929, the Electrical Section, Engineering Division, A.A.R.

In recent years the work done by the mechanical-department group has been concerned largely with locomotives and cars and their maintenance requirements. The engineering-department group has nominally concerned itself with fixed property. Actually, there can be no such sharp distinction between the work done by the two groups and, in recent years, the amount and scope of things done electrically on the railroads has grown so enormously that some form of overall supervisions which will cover fixed property, locomotives and cars is an essential. The work of standardizing and establishing practices is a must if there is to be anything like efficient use of electrical equipment.

Each group has an enviable record for avoiding the pitfalls of officialdom and for getting things done. In keeping with this reputation, they have agreed to join forces and become the Electrical Section, Mechanical and Engineering Divisions, A.A.R., and have asked the A.A.R. to endorse this move and provide a full-time secretary. This will mean added A.A.R. expense, but a saving to member roads because work will be co-ordinated and there will be only one annual meeting.

A Standard Welcome

An annual feature of the opening session of the Railway Fuel and Traveling Engineers' Association conventions is the welcome and presentation of a gavel by F. W. Bering, chairman of the board of the Sherman Hotel. He always tells how W. O. Thompson, then the secretary, and the executive committee of the old Traveling Engineers' Association visited him at the site during the construction of the new Sherman Hotel and signed up for the use of what Mr. Bering described as "the finest ventilated convention hall in the world"—the Louis XVI room, which, at the time of the inspection, had not yet acquired a roof. Their faith that by convention time it would be weathertight must have seemed like a good augury to Mr. Bering. Their confidence was justified because the old association and its successor, the Railway Fuel and Traveling Engineers' Association, have met there every year since.

Mr. Bering does not date his story. The meeting just past is the fortieth which has been held at the Sherman.

An Era Closes

Following Mr. Thompson's regime as secretary, the International Railway Fuel Association and the Traveling Engineers' Association merged and T. Duff Smith carried on the secretarial duties of the new association until his death early this year. Duff was associated with the work of the Railway Fuel and Traveling Engineers' Association for many years. He served as president of the old International Railway Fuel Association during 1911-12, incidentally the year in which that association first met at the Sherman. He will be remembered for his long career of constructive effort in behalf of the better use of fuel and of better fuel and for his 20 years of service to the present Association as its secretary.

A Challenge Is an Opportunity

The Railway Fuel and Traveling Engineers' Association has an uphill row to hoe. Its work has long been associated with steam locomotives. There is still need of constant attention to coal selection and conservation and will continue to be as long as steam locomotives remain in service. The program at the meeting this year was well balanced in its coverage of the two motive-power fields, but, with the exception of the paper on smoke control, the interest in the papers dealing with steam was noticeably less than those devoted to Diesels. The transitional difficulties are a challenge. Meeting it, the association will grow strong in the new era.

Brake-System Leakage

One of the acute problems now associated with braking of freight trains is brake-system leakage. This cropped up, in various aspects, in several of the papers and reports presented before the Air Brake Association. Unless kept within the specified limits, it becomes a hazard to, or at least greatly increases the difficulty of, smooth train control; it increases the time required to charge the brake system, which becomes particularly onerous on long trains; when it gets out of hand it requires setting

out cars and interferes with smooth operation and on-time deliveries. One report, which dealth extensively with procedures for testing for and correcting brake-system leakage, brought out the answer in its conclusion: A job completely done and not confined to the minimum which will permit dispatching the car out of the yard will be the most economical in the end. In the discussion this was carried one step further: If work is done properly in the shop and on the repair tracks, it will not have to be done in yards.

Freight-Car Reliability

Two of the reports presented before the Car Department Officers' Association deal with perennial problems. In the case of wheel and axle shop practices, definite progress is being made toward better and more uniform equipment conditions. Even here, however, the opinions as to certain details of practice have not crystallized, as was evident from the discussion which followed the presentation of the report. The other perennial problem before the meeting was hot boxes on freight cars. Here, if one were to judge the situation by the frequency and, sometimes, the bitterness of the comment of operating officers and executives, the problem is no nearer to being effectively met now than it has been any time during the last 25 or 30 years. Actually, this is too harsh a judgment. The institution of periodic repacking is one advance. The emergency specifications for oil and waste for journal-box packing which will become effective on the first of next year promise improvement of part of the problem if they are conscientiously observed. But the whole chain of conditions which must be right to overcome trouble completely seem to be so many and so complex that it is difficult to keep all of them right all of the time on a piece of equipment which can be given as little attention as is given to a freight car.

Boiler Protection

Always alert to its responsibilities, the Master Boiler Makers' Association brings new subjects into its program as conditions warrant and always reaches out into related fields in a way to keep its members from settling down into the rut of dealing exclusively with routine boiler maintenance practices. This applies particularly to boiler feedwater treatment, a subject in which the association has maintained its interest for many years. This year's program has given attention particularly to protection of the locomotive boiler from deterioration from corrosion. One report deals with the specific steps which must be taken to protect boilers while in storage. Another explores the possibilities of reducing boiler and tender-tank corrosion by interior coating, a practice with which a few railways have had favorable experience but of which many roads have little knowledge.

Convention Discussions

Floor discussions are either voluntary or forced. Often the discussions which are offered as a result of pressure on the part of a chairman are not too well thought out. Really valuable discussion is brought about by that unusual type of chairman who has the faculty of picking out the important subject matter of a report, section by section, summarizing it for the membership, asking for comments on specific points and exercising the tact to hold the discussion to those points.

What may result from a forced discussion is illustrated by an incident that happened at a predepression meeting of the old General Foremen's Association when the discussion was on the disciplining of employees. The chairman called for answers from the floor as to the reasons for discharging employees observed by different roads. A representative from a small western road, when called upon, said: "The only thing we ever fired a man for is for violating an I.C.C. rule wtihout special permission from the boss."

Joint Association Efforts

The Diesel-electric locomotive brought a lot of problems into the railroad picture, not the least of which was that of training men in the intricate details involved in the maintenance of this type of power. It also brought in electric transmission and threw it right into the laps of several thousand mechanical men who, until then, didn't know a volt from an ampere. Action on the part of the Locomotive Maintenance Officers' Association several years ago brought this fact into the open, with the result that they devoted a part of their program each year to electrical matters. They weren't too well equipped, as a group of mechanical men, to consider electrical matters, so they went out and brought a lot of electrical men into their membership. Today, a substantial part of the L.M.O.A. membership is electrical and for the last two years one of the most important and best attended sessions of the L.M.O.A. meetings has been the joint meeting between that association and the Electrical Sections, A.A.R. The character of reports in joint sessions has been high and the educational value of the sessions to both groups has been far-reaching.

* * *

REGISTRATION—COORDINATED 1950 MECHANICAL MEETINGS

Associations	Railroad Men
Air Brake	176
Master Boiler Makers'	216
Railway Fuel & Traveling Engineers'	475
Locomotive Maintenance Officers'	746
Car Department Officers'	373
Electrical Section, Mechanical Division, A.A.R.	135
Electrical Section, Engineering Division, A.A.R.	40
	2,161
	Supply Men
Railway Electric Supply Manufacturers'	236
Allied Railway Supply	737
	973
Total	3,134

ELECTRICAL SECTION

Electrical Sections Combine

Because of rapidly increasing use of electrical equipment and corresponding expansion of work done by both Sections, their work will be combined to avoid duplication and assure coverage of all subjects

By UNANIMOUS vote of members of both organizations sociation of American Railroads, endorsed the merger of present at the 1950 joint meeting, the Electrical Sections of the Mechanical and Engineering Divisions of the Asthe two bodies into the Electrical Section of the two Divisions. This year the two sections held joint meetings at the Hotel Sherman, Chicago, all day Monday, September 18. Tuesday morning, September 19, Wednesday morning, September 20, and on the afternoon of the 20th, the two Sections held a joint meeting with the Locomotive Maintenance Officers' Association.

The Railway Electric Supply Manufacturers Association held an exhibit of electrical products, and no sessions of the railroad groups were held on Tuesday afternoon to permit railroad men to visit the exhibits.

The September 18 morning session was opened by S. R. Negley, electrical engineer, Reading Company, and Chairman of the Engineering Section. Briefly he reviewed the history of the Engineering Section and told of the forthcoming vote on the consolidation of the two groups. Because of the present war effort, he said, shortages of materials could be expected. These, he added, will create a situation which will in turn be emphasized by the greatly increased use of electrical equipment of the railroads. There will also be a shortage of man power and the situation is one which will require better supervision and adherence to high maintenance standards. In conclusion, he referred to the retirement of W. S. Lacher as secretary of the Engineering Division, A. A. R., and the Engineering Electrical Section, and introduced his successor, N. D. Howard, formerly Editor, *Railway Engineering and Maintenance* and Western Editor, *Railway Age*. Mr. Negley, then turned the meeting over to W. S. H. Hamilton, electrical engineer equipment, New York Central and Chairman of the Electrical Section, Mechanical Division.

Mr. Hamilton called attention to the fact that this was the first time the two sections had met jointly and urged the consolidation of the Sections. He also spoke with regret of the passing of Frank O. Marshall, chief engineer of the Pullman Company, who had been elected to the office of Chairman, Electrical Section, Mechanical Division, A. A. R., but whose death on January 11, 1950, prevented his serving in this capacity. Mr. Hamilton who was Vice Chairman (East) succeeded to the office of Chairman. Mr. Marshall was a man of exceptional ability who had the affection of all who knew him and, at Mr. Hamilton's request, the members of the two sections stood in silent tribute to the passing of Mr. Marshall.

Election of Officers

Officers elected to serve during the forthcoming year are as follows:

Chairman: L. C. Bowes, electrical engineer, Chicago, Rock Island & Pacific.

Vice-Chairman (East): H. C. Paige, assistant mechanical engineer, New York, New Haven & Hartford.

Vice-Chairman (West): R. I. Fort, assistant research engineer, Illinois Central.

Members, Committee of Direction: K. T. Benninger, general electrical supervisor, Chicago & Eastern Illinois; S. B. Pennell, assistant engineer, New York Central: L. E. Grant, engineer of tests, Chicago, Milwaukee, St. Paul & Pacific.

Mr. Hamilton conducted the presentation of reports and discussion concerning the Mechanical Section reports, and those for the Engineering Section were conducted by Mr. Negley.

Consolidation of Sections

Chairman Hamilton introduced the question of consolidation of the two Electrical Sections, and called on K. H. Gordon, assistant electrical engineer, Pennsylvania, for discussion. Mr. Gordon said the subject has been under consideration for quite a period of time by representatives of the two Sections—the question being, "Is it worth while." The rules of organization, he said, had gone through many revisions, and what they considered a satisfactory constitution had been developed. Due to the growth and use of things electrical, he said, most electrical subjects are of interest to the members of both Sections. He expressed the opinion that the consolidation will not involve any difficulties except that the consolidated Section must have a full-time secretary. This, he explained must be decided in A. A. R. headquarters in Washington, D. C.

All members had received a letter of proposal and Mr. Gordon moved that the two Sections be consolidated to form the Electrical Section of the Engineering and Mechanical Divisions, Association of American Railroads. The motion was seconded, and the members of the two Sections present, voting separately, gave unanimous approval of the consolidation.

H. F. Finnemore

N. D. Howard

S. R. Negley

Electrical Section—Engineering Division Association of American Railroads

Officers

S. R. Negley, *Chairman*, electrical engineer, Reading, Philadelphia, Pa.

H. F. Finnemore, *Vice Chairman*, chief electrical engineer, Canadian National, Montreal, Canada

N. D. Howard, *Secretary*, Electrical Section, Engineering Division, A. A. R., Chicago

Wire, Cable and Insulating Materials

The first report, presented by C. R. Troop, assistant engineer, New York Central, was that of the committee on Wire, Cable and Insulating Materials. The report is concerned primarily with specifications for, and the standardization of, various types of wire and cable. Concerning wire and cable for use on locomotives and cars, the report states that in the opinion of the committee, a rubber or synthetic rubber insulated, neoprene sheath type of cable is superior to the varnished cambric and other types of materials which are now being supplied for this purpose. It is hoped that, with information to be obtained from a proposed questionnaire and meeting, a standard specification can be written.

The report is signed by C. R. Troop, (*chairman*); G. L. Sealey (*vice-chairman*), assistant engineer, Reading; E. R. Ale, office of electrical engineer, Pennsylvania; L. S. Billau, electrical engineer, Baltimore & Ohio; L. L. Carter, assistant chief engineer, Anaconda Wire & Cable Company; J. E. Gardner, electrical engineer equipment, Chicago, Burlington & Quincy; J. W. Hackett, sales engineer, Okonite Company; Roy Liston, supervisor automatic train control and train stop, Atchison, Topeka & Santa Fe; A. E. McGruer, electrical engineer, Canadian Pacific; H. C. Paige, assistant mechanical engineer, New York, New Haven & Hartford; P. W. Pleasant, electrical supervisor and chief fire inspector, Chicago, Indianapolis & Louisville; R. F. Pownall, general foreman, New York, New Haven & Hartford; and H. E. Purdy, district engineer, American Steel & Wire Company.

The part of the report which deals with wire and cable for locomotives and cars was designated by Mr. Hamilton (N. Y. C.) as an important assignment. Addenda A of the report introduces the question as to whether No. 25 or No. 24 wire should be used for stranding. Mr. Hamilton said that where cable is not subject to flexing, the question is unimportant, but that in his opinion, No. 25 is better than No. 24 for motor leads.

J. E. Gardner (C. B. & Q.) called the committee's attention to the fact that for some of the smaller sizes of wire, No. 25 strand would not be as flexible as some which are now being used.

Roy Liston (A. T. & S. F.) expressed agreement with Mr. Gardner's statement. He added that wires are subject to breakage where the conduit is not well-filled with cable and expressed the belief that nothing less than 19 strands for No. 14 wire should be used. He added that experiments were now being conducted with a 37-strand, No. 14 wire. Mr. Troop (N. Y. C.) expressed the opinion that the question of stranding can be settled satisfactorily by means of the questionnaire which the committee will send out.

With reference to solderless, or pressure-applied terminals, Mr. Hamilton said their effectiveness might also be determined by means of a questionnaire addressed to those who have used them for several years. He does not think any trouble of consequence will develop in the case of smaller sizes, but said that possible corrosion and the use of untinned wire might introduce some problems when the terminals are used on larger size cables.

A. E. Voigt (A. T. & S. F.) suggested the voltage drop in 32-volt circuits be given special attention in determining the requirements and effectiveness of pressure applied terminals.

L. C. Bowes

Fred Peronto

W. S. H. Hamilton

Electrical Section—Mechanical Division Association of American Railroads

Officers

W. S. H. Hamilton, *Chairman*, engineer electrical equipment, New York Central New York

L. C. Bowes, *Vice Chairman*, electrical engineer, Chicago, Rock Island & Pacific, Chicago

Fred Peronto, Secretary, Electrical Section, Mechanical Division, A. A. R., Chicago

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Power Supply

The report of the joint committee on power supply was presented by C. P. Trueax, assistant electrical engineer, Illinois Central. The first part of the report describes the lighting and distribution systems for the combination Diesel and Steam locomotive shop of the New Orleans Union Passenger Terminal. The second part is concerned with external power supply for operating Diesel locomotive cooling fans in the shop. The last part of the report deals with the standardization of plugs and receptacles for passenger-car wayside power and the relative advantages of a three-conductor versus four-conductor cable. The first two parts of the report are reproduced in the following.

Part I—Power Supply, Lighting and Distribution Systems for the Combination Diesel and Steam Locomotive Shop, New Orleans Union Passenger Terminal

By R. H. Herman and C. P. Trueax

A complete new terminal facility, comprising passenger station, coach yard and locomotive shop are now under construction at New Orleans, La. The project was sponsored jointly by the railroads with terminals in that city and will replace existing passenger stations, coach yards, and shops of the tenant lines.

Considerable thought was given in planning the shop and associated facilities for maintenance and repair of both steam and Diesel locomotives operating in passenger service into and out of New Orleans. The layout incorporates the most desirable features of modern shop design in both layout and equipment.

A survey of the requirements of tenant lines developed that no facilities would be required for heavy repairs to either steam or Diesel locomotives and the layout was accordingly based on running repair, progressive maintenance or turn-around inspection work. The Diesel switcher locomotives to be operated by the terminal company can be adequately maintained with the equipment provided, or in event of heavy repairs, sent to one of the tenant lines for such work.

It is probable that few if any steam locomotives will operate in passenger service into New Orleans by the time the work is completed. Consequently facilities for steam locomotives have been reduced to an absolute minimum and arranged so that the inspection pits can be converted for servicing Diesel power at a future date.

The locomotive terminal facilities comprise a shop building 120 ft. 4 in. wide by 182 ft. 2 in. long with two full length inspection pit tracks for two or three unit Diesel locomotives, a shorter inspection and repair track with a 100-ft. inspection pit for single units or switchers, a wheel release and storage track and one through inspection pit track, partitioned off from the remainder of the building for steam locomotive or Diesel work as required. The two full-length inspection pit tracks for Diesel locomotives are provided with conventional platform and depressed floor arrangement. Provisions have also been made so that the steam locomotive track can be converted at a later date for Diesel work by depressing the floor and installing necessary platforms. The floor level adjacent to the 100-ft. inspection pit track and wheel release track is at the top of the rail level.

An extension 90 ft. 8 in. wide and 60 ft. 9 in. long at the end

of the main portion of the building provides space at platform level for offices, storehouse, parts reconditioning room and filter cleaning room. The basement contains additional storehouse space, wash and locker rooms and a heavy storage room.

The principal items of equipment in the shop building itself will include a 7½-ton overhead traveling crane spanning two tracks, a 60-ton drop table for single pair of wheels, a small gas fired low pressure boiler to supply steam for parts and filter cleaning, a few machine tools for steam locomotive work and the necessary tools and equipment for Diesel locomotive running repair or progressive maintenance work.

The balance of the facilities comprising the engine terminal consist of a 150-ft. inspection pit track immediately outside the building, steam engine wash platform, Diesel locomotive washing and servicing platform, oil house, Diesel fuel and storage and pumping equipment, sand house, sand storage and dispensing equipment, and water columns for steam locomotives.

Electrical energy for power and lighting in the engine terminal zone is supplied from an outdoor platform mounted transformer bank, consisting of three 50 kv.a. single-phase transformers for 3-phase, 230 volt power and one 75 kv.a. single-phase transformer for lighting.

The layout for ground floor level light and power is shown in Fig. 1 and for platform level in Fig. 2.

Light and power entrance switches and distribution panel switches are all of thermal-magnetic circuit breaker type, conveniently located with reference to load.

Three power panels serve a connected load of 190 hp. Of this total, the 60-ton drop table represents 20.75 hp. and the 7.5-ton crane represents 25.5 hp. The largest motor, 25 hp., is on a portable welding machine.

There are four main panels and five subpanels in the lighting system. Pit lights are of conventional design with fixtures flush mounted in the pit walls. Fluorescent lights are used above and below platforms at the full length inspection pit tracks and in the parts reconditioning room, and mercury vapor in the remainder of the locomotive servicing area within the building and at the inspection track outside of the building.

Vapor-tight fixtures are used throughout. The fluorescent units accommodate two 40-watt tubes each, are spaced on 8-ft. centers and are of special design for use under platforms and of conventional design for use above platforms. The mercury vapor units use the 400-watt FH-1 lamp.

(Note: Because the large tracings of Figs. 1 and 2 above referred to, showing layout for ground floor level and platform level light and power, were not readily adaptable for reproduction, anyone interested in securing prints of these figures may do so upon request to C. P. Trueax, assistant electrical engineer, Illinois Central Railroad, Chicago 5, Ill.)

Part II—Shop Operation of Cooling Fans on Diesel Locomotives to Ventilate Engine Room

By R. H. Herman

Practically all modern Diesel locomotive maintenance and repair shops are provided with fixed exhaust or ventilating fans to remove fumes from the building.

The removal of heat from the locomotive engine room itself is likewise very important since locomotives arrive in the shop with the engines, cabs and equipment at relatively high temperature.

Inasmuch as mechanics must start repair work on the locomotive immediately, there have been numerous complaints regarding the heat, particularly during hot summer months. Various measures have been tried, such as the use of portable exhaust fans or blowers placed in the cab doors, to remove heat and cool the engine room, but none of these arrangements have been fully satisfactory. If large fans are used, they create objectionable drafts and block passageway through doors, while small fans do not move sufficient air to be effective.

The 1500 hp. road freight locomotive units now being produced by one manufacturer are equipped with an a.c. alternator direct connected to the Diesel engine. The alternator furnishes variable frequency and voltage a.c. three-phase energy for operation of engine water cooling fans and traction motor blowers. The advantages of this design are primarily to vary speed of cooling fans and blowers as the engine speed varies with the result that cooling effect is proportional to speed and load.

The speed of the 16 pole alternator varies with the engine speed and consequently, since excitation is constant, both the frequency and the voltage vary through a wide range. When the engine is running at 275 rpm., the frequency of generated a.c. energy is approximately 37 cycles and voltage 55, while at a full speed of 800 rpm., the frequency is approximately 107 cycles and voltage 149 volts. When the alternator is generating 60 cycles the voltage will be approximately 89 volts.

There are four engine water cooling fans on each locomotive unit, each of which moves a large volume of air in through the body filters and exhausting it out the top of the locomotive, providing effective ventilation and cooling of the engine room. It is practicable to install a double throw switch, receptacle and wiring on the locomotive unit so that one of these fans, usually No. 4, can be operated from an outside power source to cool the engine room when the locomotive is in the shop. Although normal voltage is 89 at 60 cycles, satisfactory operation can be secured by a power

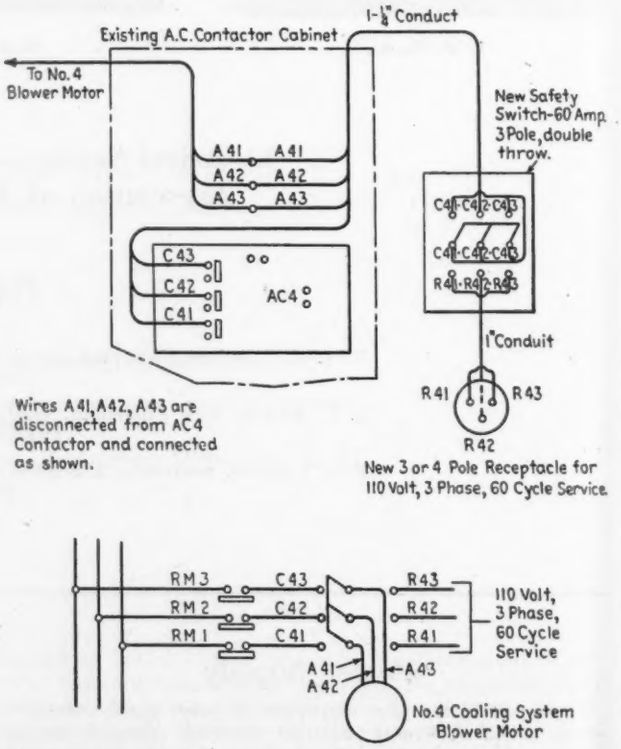


Fig. 1—Diagram of wiring changes on Diesel locomotive unit to permit operation of No. 4 blower from outside source while locomotive is in shop

service of 110 volt, three phase, 60 cycle. From tests it was found that the load is equivalent to a 5 hp. motor for the operation of each fan.

Fig. 1 shows a schematic diagram of the equipment and wiring required on the locomotive. A 60 amp., 3-pole double throw nonfusible safety switch is installed in each locomotive unit adjacent to the a.c. contactor cabinet and a 3 or 4 pole receptacle at a point convenient to the outside. One satisfactory location is to place the receptacle under the locomotive on the side adjacent to the high voltage cabinet. Under normal road conditions, the double throw switch is in the top position and the No. 4 fan operates from energy supplied by the alternator. By placing it in the down position and plugging an outside 110 volt, 3 phase, 60 cycle service into the receptacle, the fan can be started and stopped by its contactor, providing satisfactory ventilation for the engine room.

There are several practical methods of supplying 110 volt, 3 phase, 60 cycle service at convenient locations in the Diesel

shops where plug connection can be made to the receptacle on a locomotive. The type of system to be used will depend upon local conditions such as normal shop voltage, availability of transformers, etc.

One method involves the installation of a 110 volt, 3 phase, 3 wire system throughout the shop with receptacles at convenient locations, as shown on the schematic wiring diagram under Fig. 2. The arrangement covers single receptacles located between tracks on the approximate centerline of the locomotive, each receptacle to serve one cooling fan, with a safety switch or circuit

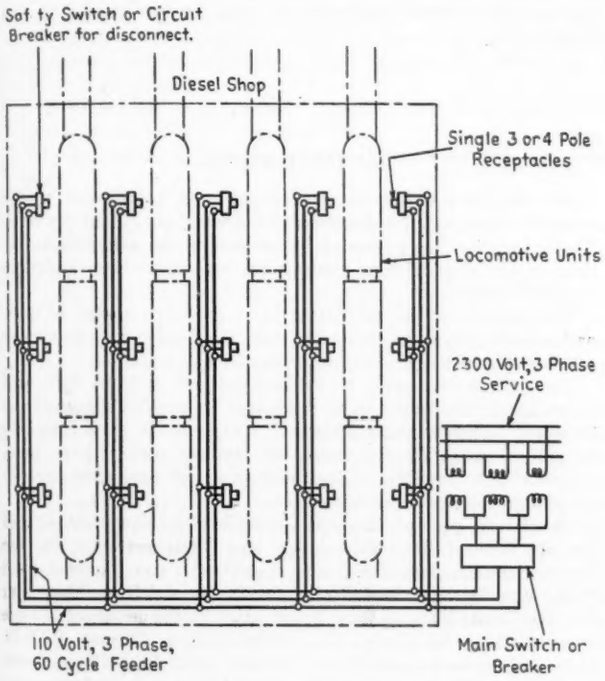


Fig. 2—Diagram of wiring for 110-volt, 3-phase, 60-cycle system in a typical Diesel shop having four maintenance tracks for three-unit locomotives

breaker for disconnect purposes. Single receptacles only are shown on both sides of each track to permit connection to the receptacle regardless of which side of the locomotive it is on.

The Diesel shop shown has a track capacity for 12 Diesel units and it can be safely assumed that all 12 will not be operating at one time. Three 15 kv.a. transformers connected delta will provide for 9 fans at full load with a 400 amp. safety switch or 300 amp. breaker as a secondary main disconnect. Copper wire sizes should be adequate for the expected maximum load.

The schematic diagram also shows a safety switch or breaker ahead of each receptacle. If desired these might be omitted since the fans can be started and stopped by operating the a.c. fan contactor on the locomotive with the plug and receptacle forming the disconnect.

An alternate arrangement is available if existing 220 or 440 volt, 3 phase feeders in the shop are of adequate capacity for the additional load, thus eliminating the necessity for a complete distribution system. This arrangement covers the use of three single or one 3 phase dry type transformer, either 220 or 440 volt primary to 110 volt delta connected 3 phase secondary. These transformers can be mounted inside the building, either above or below the platform on posts or columns. Fig. 3 shows a schematic diagram of this system.

You will note that the system shown in Fig. 2 provides a receptacle for each Diesel unit, so located that it is possible to plug into the receptacle on one side of the locomotive, regardless of which side it is on, avoiding the necessity of feeding cables across inspection pits. Fig. 3 shows a simplified arrangement with double receptacles between every two tracks. This arrangement of receptacles could also be adopted with 110 volt, 3 phase distribution to reduce cost and simplify wiring.

The arrangement shown in Fig. 3 will require three 3 kv.a. single phase or one 10 kv.a. three phase transformers at each location to serve two 5 hp. motors. The safety switch should be 100 amp. or circuit breaker 90 amp. if they are desired for use as disconnects at each transformer location. The disconnecting switch or circuit breaker may be installed ahead of the transformer for short circuit protection and in this case the amperage rating would be reduced since they would be in the 220 or 440 volt circuit.

Variations in the above arrangements will be required to suit conditions in different shops. It is even possible to install one bank of transformers with receptacles to serve all the units on two inspection tracks. This will require extremely long portable cables which present a safety hazard on floor or platform.

The diagrams and comments will serve to illustrate the general requirements of a system to operate the cooling fans and ventilate

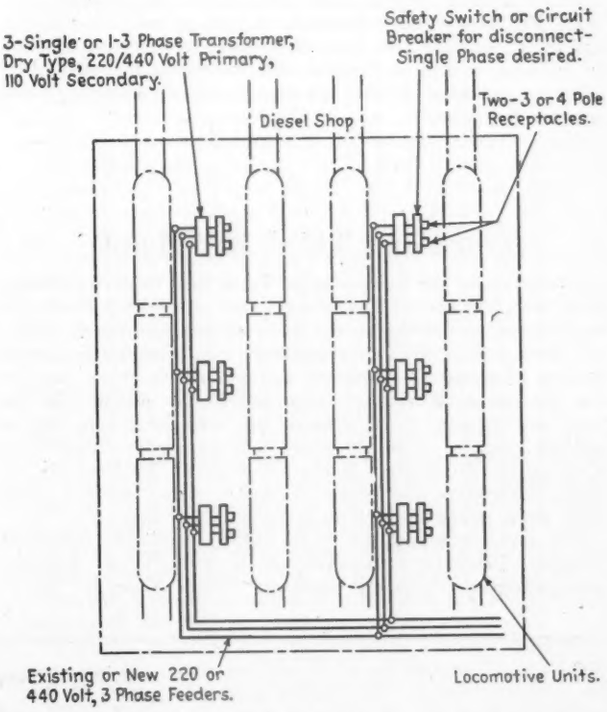


Fig. 3—Diagram of wiring for 110-volt, 3-phase, 60-cycle system in a typical Diesel shop using existing 220- or 440-volt power service through dry type transformers

locomotive cabs, subject to variations to suit individual shop requirements.

The report is signed by C. P. Trueax (*chairman*); S. D. Kutner (*vice-chairman*), assistant engineer, New York Central; L. C. Bowes, electrical engineer, Chicago, Rock Island & Pacific; R. E. Hauss, assistant maintenance supervisor, Cincinnati Union Terminal; R. H. Herman, engineer of shops and equipment, Southern; H. A. Hudson, signal and electrical superintendent, Southern; F. A. Rogers, engineer, electric lighting and distribution, New York, New Haven & Hartford; G. L. Sealey, assistant engineer, Reading; C. S. Stringfellow, assistant to electrical engineer, Atlantic Coast Line; W. D. Taylor, electrical engineer, Canadian National; A. L. Veith, assistant electrical engineer, Wabash; and Laurence Wylie, electrical engineer, Chicago, Milwaukee, St. Paul & Pacific.

Discussion

The second section of the report was presented by R. H. Herman (Southern), and Mr. Negley (Reading) asked him if he had such

a ventilating system in service. Mr. Herman replied that the Southern is, or will be, using it in all shops servicing locomotives equipped with a.c. motor-driven ventilating fans.

Concerning the use of cables for standby power, Mr. Hamilton said he wished to go on record as endorsing the continued use of the ground wire. Mr. Negley concurred with Mr. Hamilton.

H. W. Dillon, (T. & N. O.) said that the use of the large cables caused heavier maintenance costs because the long cables are difficult to handle. He advocated closer spacing of outlets and the use of shorter cables. He also suggested wagons for moving cables.

Electrolysis

A progress report of the Committee on Electrolysis, not included in the printed reports was presented by Mr. Negley for A. E. Archambault, assistant engineer, New York Central. It includes the final report on the effect of electric current on reinforced concrete. A report for printing will be presented next year. Mr. Negley called attention to, and recommended highly, the report compiled over a period of years on corrosion of metal in overhead structures. He also called attention to bulletins on corrosion published by the American Petroleum Institute. There was no discussion.

Track and Third Rail Bonds

The report of the Committee on Track and Third Rail Bonds deals with revision of the Manual, and arc-welded bonds for heavy traction. Concerning the latter subject, the report states:

"As reported in the 1949 committee's report, interest in electric welding of bonds still continues, and the electric welder used by the Chicago, Milwaukee, St. Paul and Pacific, weight—325 lb., rated at 150 amp. at 30 volts, 50 per cent duty cycle, with a welding range of 37 to 175 amp.—is being used successfully in applying the 4/0 traction bonds. While we do not have any detailed information, electric-arc welding of signal bonds is being used more extensively and is creating more interest."

The report is signed by A. B. Costic (*chairman*), electrical engineer, Delaware, Lackawanna & Western; C. R. Wadham (*vice-chairman*), assistant engineer, Illinois Central; W. P. Bovard, manager, rail bond division, Ohio Brass Company; H. H. Febry, supervisor specialty sales, American Steel & Wire Company; C. G. Lovell, Chicago, Milwaukee, St. Paul & Pacific; L. C. Walters, assistant to vice-president, signal and electrical, Southern; and R. C. Welsh, general foreman, office of electrical engineer, Pennsylvania.

The report was presented by Mr. Wadham (Illinois Central).

Discussion

A written discussion concerning A.S.A. standards was received from H. F. Brown, electrical engineer, New York, New Haven & Hartford, who is now escorting a group of European railroad representatives over American railroads and manufacturing plants. These standards have to do with types of lineman's protective equipment which would effect a saving of rubber and still provide adequate protection. This was a war provision, but Mr. Brown called the attention of the Section to these specifications since there may again be need for the results of this study.

Illumination

The first part of the report (offered as a supplement to the manual) deals with floodlighting of railroads' yards and the table "Yard Location" is presented to summarize the installation features in five retarder type yards which are generally conceded to be well lighted.

The purpose of this tabulation is to provide a means of comparison whereby the designer of a new installation may determine whether his plans are within reasonable bounds.

The data shown apply to yards which are straight from end to end, and relatively free of restrictive features in placement of floodlight supports and training of projectors. A yard involving curves or obstructive or restrictive features may require more supports and, possibly, a greater number of projectors, for illumination of an equivalent area.

The second part of the report describes the characteristics of the new line of fluorescent lamps now being marketed by the larger manufacturers. These are, respectively, the Standard Cool White, the De Luxe Cool White, the Standard Warm White and the De Luxe Warm White. Other new lamps mentioned as a 90-watt, 60-in., 4860-lumen fluorescent lamp, a 300-watt, PAR-56 bulb incandescent spotlight, a 200-watt, PAR-56 bulb projector spotlight, a 500-watt and a 750-watt PAR-52 bulb, reflector-type lamps, and a 300-watt R-30 bulb photoflood lamp.

The remainder of the report describes the various ways of replacing lamps and describes their respective advantages and disadvantages as follows:

Yard Location

Yard Characteristics	Willard, Ohio *Westbound*	Willard, Ohio *Eastbound*	Cumberland, Md.	Enola, Pa. *Westbound*	North Platte Nebr.
Type	*Retarder*	*Retarder*	*Retarder*	*Retarder*	*Retarder*
Number of tracks	20	29	17	35	42
Number of ladders of considerable length	4	4	3	2	5
Sq. ft. of area to be lighted	960,000	1,400,000	368,000	1,870,000	1,400,000
Length of yard—hump crest to pullout end	6,300 ft.	6,000 ft.	2,925 ft.	7,100 ft.	3,600 ft.
Greatest width—body of yard	250 ft.	400 ft.	200 ft.	430 ft.	600 ft.
Lighting System					
Unidirectional or parallel-opposed	Par. Op.	Par. Op.	Par. Op.	Uni-Direc.	Par. Op.
No. of floodlight supports	6	6	4	6	7
Height of floodlight supports above rail top	100 ft.	100 ft.	100 ft.	100 ft. (5) 50 ft. (1)	100 ft.
No. of floodlights for					
Yard head lighting	14	11	8	16	9
Body lighting	29	24	17	55	30
Pullout end lighting	2	2	3	3	2
Size of lamps—watts	1,000	1,000	1,000	1,000	1,500 (38) 1,000 (3)
Avg. watts per sq. ft.	0.047	0.0264	0.076	0.041	0.043

When Type F lamps were first announced, the service life was tentatively placed at 1000 hours. Soon it was raised to 1500 hours where it remained for a year or two. During most of the 1940's, the nominal rating was 2500 hours. Advances in the art have

improved the life, which, according to manufacturers' published values, is now 7500 hours for hot cathode lamps on the basis of 3 hours' burning per start, and 4000 to 6000 hours for slimlines, depending on the frequency of starting. Whether this life is secured in service, the committee does not venture to say at this time.

Assuming the correctness of the mortality curve based on 7500 hours of life (Fig. 1), it is interesting to speculate upon what action the user should take to secure the maximum of service life at the minimum of expenditure. In the matter of lamp replacement, he has a choice of three major methods of procedure, namely:

1. Replace lamps as they fail.
2. Replace failed lamps periodically.
3. Replace all lamps of an installation at the end of a fixed number of hours of burning. This is generally referred to as group replacement.

In evaluating these methods against each other, some of the factors to be taken into account are:

A. The relatively low price of lamps as compared with labor cost.

B. Purchasing, shipping and storage expense.

C. Time consumed by the workman going to the installation and returning to his usual station, including:

a) Time consumed in securing new lamps.

b) Time consumed in securing and transporting ladders or similar aids.

c) Time consumed in replacing failed lamps, which is dependent upon accessibility of the fixtures and their type (open or enclosed).

Replacing lamps as they fail is liable to be quite costly unless conditions are extremely favorable. On the other hand, this method keeps the installation looking fit, tends to maintain the level of illumination, and secures full lamp life.

Replacing failed lamps periodically, say once per week or other regular time, will decrease labor cost materially and secure full lamp life. Conversely, some lamps will be inoperative for a considerable part of the fixed period. Whether this will seriously affect the light level or impair the appearance of the installation will depend upon the type of the fixtures and the number of lamps in each. For example, to cite extremes, a failed lamp in an open, single-lamp fixture stands out prominently, whereas, in an enclosed or louvered multiple-lamp fixture, it may pass almost unnoted.

If this procedure is followed in a large new installation, much replacement activity will begin at about 70 per cent of rated life (Fig. 1) but as time goes on and new lamps become interspersed among older lamps which have been in service for varying lengths of time, the mortality curve flattens and failures over a given period of time become substantially constant and can be predicted with considerable accuracy.

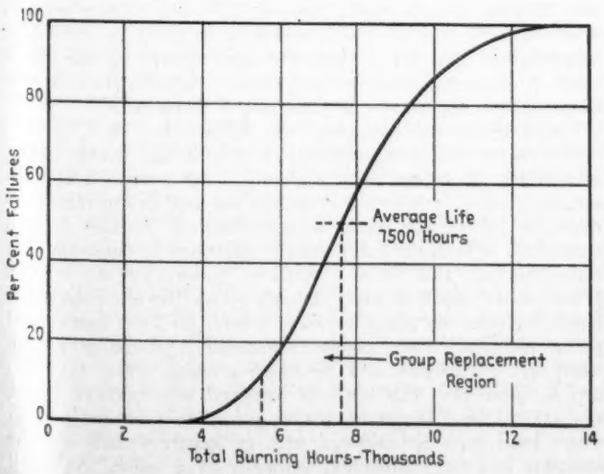


Fig. 1—General mortality of fluorescent preheat lamps under life test conditions

When this replacement procedure is used, it is imperative to use "noblink" starters. While these starters cost more initially than the simpler type, they last longer, prevent the annoyance of blinking lamps, and protect the ballasts against overheating and deterioration.

Group replacement may be used to advantage when the cost of replacement of a few lamps at a time is excessively high. If this method is employed, the saving in labor cost must be at least equal to the value of the lamp life thrown away.

This method tends to maintain the light level because many of the lamps will be retired before they reach their lowest efficiency. However, this advantage is counterbalanced or, perhaps, overbalanced by the outages which begin to occur at about 40 per cent of the rated life of the lamps (Fig. 1). The number of outages will depend upon the point on the mortality curve which is selected for group replacement. The determination of this point will depend largely upon the character of the installation and the evaluation of costs as previously described. In general, it would appear to be unadvisable to place it much beyond 65 per cent of rated life, when about 10 per cent failures may be anticipated. Outages not only lower the light level but have a depressing effect upon the morale of personnel and give the installation an appearance of neglect and dilapidation.

In the use of this method of replacement, starters, if required, must of necessity be of the "noblink" type.

The report is signed by E. R. Ale (*chairman*), office of electrical engineer, Pennsylvania; L. S. Billau (*vice-chairman*), electrical engineer, Baltimore & Ohio; J. E. Gardner, electrical engineer equipment, Chicago, Burlington & Quincy; V. R. Hasty, electrical engineer, Union Pacific; H. A. Hudson, signal and electrical superintendent, Southern; S. D. Kutner, assistant engineer, New York Central; F. B. McConnell, assistant signal electrical engineer, Pittsburgh & Lake Erie; A. E. McGruer, electrical engineer, Canadian Pacific; F. A. Rogers, engineer, electric lighting and distribution; G. L. Sealey, assistant engineer, Reading; W. D. Taylor, electrical engineer, Canadian National; and C. A. Williamson, electrical engineer, Texas & New Orleans.

Discussion

The report was presented by E. R. Ale (P. R. R.). W. S. H. Hamilton (N. Y. C.) asked if the daylight fluorescent is equivalent to the blue incandescent lamp for color matching, and Mr. Ale replied that for this purpose the daylight fluorescent is very poor. K. T. Benninger, general electrical supervisor, Chicago & Eastern Illinois, asked if the daylight lamp is good in combination with other fluorescent lamps where color rendition is important. Mr. Ale replied that it is only good for greens and blues, and for color rendition, it is better to use 4500-deg. white lamps with the de luxe lamps.

W. S. H. Hamilton (N. Y. C.) asked about the "warm-tint" lamp, and Mr. Ale replied that it did not give good color rendition.

S. R. Negley (Reading) asked if the committee favored unidirectional lighting for yards to which Mr. Ale replied, "Generally yes, but it is not always possible."

Overhead Transmission Line and Catenary Construction

On specifications covering bronze and copper trolley wire, in collaboration with representatives of the American Transit Association and the A.S.T.M., the Committee on Overhead Transmission Line and Catenary Construction has the following to offer:

The American Society for Testing Materials, Committee B-1, has made no changes in the specifications for trolley wire during the past year. It has under consideration a proposed standard gauge for acceptance of grooved trolley wire, but this has not yet been adopted. This gauge is proposed to replace the commercial splicers which are currently being used as gauges for acceptance testing.

The results of the mathematical recheck of areas and weights, as given in the specifications for shaped trolley wire, are being tabulated and prepared for publication as a matter of record.

Electrical Section specifications for wire crossings, which were

prepared jointly with the Edison Electric Institute, are based largely on the fifth edition of the National Electrical Safety Code. Since this edition was adopted, there has been in existence a Committee on Interpretations which has functioned to clarify and interpret various rules of the Code when questions as to intent have been raised. This Section is represented on this Committee. A considerable number of requests for interpretations are received and passed upon each year.

Any questions regarding the meaning of any N.E.S.C. requirement may be referred to Mr. John A. Dickenson, National Bureau of Standards, Washington 25, D. C., who is chairman of the Committee on Interpretations.

The American Standards Association has established a new Sectional Committee on Bare Electrical Conductors to be known as Committee C-7. Committee 3 was asked to furnish a representative on this new sectional committee. Mr. K. H. Gordon, assistant electrical engineer, Pennsylvania, has generously agreed to accept this assignment.

The report is signed by E. M. Hastings, Jr. (*chairman*), chief engineer, Richmond, Fredericksburg & Potomac; A. B. Costic (*vice-chairman*), E. H. Anson, vice-president, Gibbs and Hill, Inc.; K. H. Gordon, assistant electrical engineer, Pennsylvania; S. W. Law, signal engineer, Northern Pacific; John Leisenring, electrical superintendent, Illinois Terminal; S. R. Negley, electrical engineer, Reading; H. H. Newman, general electrical foreman, Illinois Central; P. E. Snead, chief signal and electrical inspector, Southern; and Sidney Withington, engineering assistant to executive vice-president, New York, New Haven & Hartford.

Discussion

The report was presented by E. M. Hastings, Jr. (C. & O.), who then called on K. H. Gordon (P. R. R.), for further comment. Mr. Gordon said the code is accused of being abstruse, and to clarify the situation, there was set up a Committee on Interpretation. This committee, Mr. Gordon said, has had to pass on from 15 to 25 questions per year, the last one on wire crossing, was answered just two weeks before the Sections' meetings. These interpretations, he said, are available to those who may want them.

H. E. Preston (I. C.) asked if the overhead contact wire should be positive or negative, and said that some European railroads had made it negative claiming that this reversed polarity reduces wear. W. S. H. Hamilton (N. Y. C.) said that some members of the American Transit Association had tried such a scheme.

Radio and Communication on Rolling Stock

The report of the committee on Application of Radio and Communication Systems to Rolling Stock includes 38 report pages of specifications to cover spark suppression and mitigation of interference to radio reception or other communication circuits from the operation of railroad electrical equipment and nine pages covering specifications for intra-train telephone systems on rolling stock. The first portion covers old specifications of the 1945 Communication Section Report and these are recommended for inclusion in the Electrical Section Manual. The last nine pages are new material.

The report is signed by W. S. Heath (*chairman*), electrical assistant, Atchison, Topeka & Santa Fe; W. H. Mims, electrical engineer, Central of Georgia; F. E. Gould, equipment inspector, New York Central; and D. F. Dunsmore, assistant electrical engineer, Chesapeake & Ohio.

Discussion

The report was presented by W. S. Heath (A. T. & S .F.). W. S. H. Hamilton (N. Y. C.) asked if there is anything in the report which concerns fluorescent light interference. Mr. Heath replied that it is considered as being covered by the part of the report dealing with starters, and added that if the starter is the source of the trouble, it should be replaced. L. E. Kearney (Communications Section, A. A. R.), said that fluorescent lamps do cause some interference, and that method C (Par. 1, page 7) is the only corrective method offered in the report. Mr. Gould (N. Y. C.) said that interference does come back through lines to the board, and that it is necessary to try with small condensers to ground to eliminate it.

Motors and Controls and Shops

The first section of the Report of Joint Committee on Motors and Controls and Repair Shop Facilities and Practices describes three types of controls used for turntables, and also a fourth (namely, full-automatic, full-magnetic push-button type control) which has desirable features but which has found little application.

The remainder of the report which describes the Pennsylvania's new Diesel electrical repair shop at Altoona, Pa., discusses the load testing of traction motors, and high-frequency testing of traction motor armatures is included herewith in full, except for a floor plan of the Altoona shop.

Shop Equipment and Facilities for Repairing Motors, Generators, etc., on Diesel and Electric Locomotives

The Pennsylvania has nearly completed at Altoona, Pa., facilities for repairing, rewinding and overhauling electrical apparatus removed from Diesel-electric locomotives. These facilities are housed in a three-story building approximately 65 ft. by 270 ft., formerly used as a tank shop, and are located on the second and third floors; the first or ground floor being reserved for other work. Traction motors, main and auxiliary generators and blower and fan motors are handled on the second floor, and relays, contactors, switches and miscellaneous electrical apparatus on the third floor.

Apparatus received for repairs is moved from the storehouse platform, outside of the shop, to the second floor motor and generator repair shop, or the third floor, where miscellaneous work is done, with a 3-ton fork-type type lift truck by way of a 20,000-lb. capacity electric elevator. Practically all material is handled into and out of the shop via this elevator. However, for emergencies, a hatch has been provided in the floor of the motor generator shop, through which motors and generators may be raised and lowered directly from cars placed in the first floor of the shop.

To the left of the entrance to the motor generator shop on the second floor is a cleaning and dismantling room. In this room are located a degreaser, a blowing booth, work benches, and racks for the necessary tools and machinery used in the dismantling of apparatus. The room is served by a 4-ton crane.

Every piece of apparatus entering the shop goes to the cleaning room where it is assigned a shop serial number, and items other than traction motors are given a prefix letter If generators, the prefix letter is "G," and if auxiliary apparatus such as M. G. sets, blowers, etc., the prefix letter is "A." This number remains with the particular piece of apparatus throughout its entire life, regardless of how many times the item returns to the repair shop. A metal tag carrying this number is attached to each part removed from each motor or generator in this room.

Handling of a traction motor is as follows:

The motor pinion is removed by a hydraulic pinion puller, after which the entire motor is placed in the trichlorethylene degreater. Non-silicone insulated motors are held in the vapor produced by heating the liquid to approximately 185 deg. F. with steam heat coils in the bottom of the degreaser for approximately three minutes, and silicone insulated motors for one minute. While in the vapor, a wand through which the trichlorethylene liquid is forced by pump, is used to flush off loose particles of grease and dirt. After removal, the motor is placed on a turntable cart and pushed into the blowing booth, where the loose dirt is blown off. This booth is equipped with curtains, lights, and exhaust fan. The motor is then placed in a vertical position where head bolts are removed with an impact wrench and the armature and head lifted out vertically by a crane. All small parts removed are placed in a basket to again be run through the degreaser. The armature, after removal, is given a short dip

in the degreaser, as, due to the short original exposure to the vapor, some grease remains on the armature. Provision is made for the installation of a corn-cob blast, which will eventually be used to remove any dirt which may still cling to the armature. Under present operations, the blowing booth is being used for this cleaning. The same treatment is given the motor frame, after removal of the armature, as is given the armature. The armature is then placed on a portable armature stand to start its trip up the west side of the shop, and the motor frame is moved outside of the cleaning room to the east side of the shop for its trip through the repair line.

The bearings which have been removed in the cleaning room are put through a demagnetizing coil and then placed in the degreaser for several minutes, after which they are immediately passed through an opening into the bearing room. This bearing room is 11 ft. long by 7 ft. wide and 8 ft. high and is provided with an exhaust fan, the entering air passing through air filters. The room is equipped with two 8-power magnifying glasses, suitable benches and tools, and lighted to an intensity of 50 foot-candles. After receiving the bearing from the degreaser, it is carefully examined under an 8-power magnifying glass; and if no defects can be noted, the bearing is dipped into a slushing solution, wrapped in wax paper, and pushed through a flap to the main room, where it is placed in storage until needed in the re-assembling of the traction motor. If any marks are detected on the rollers or races to cause any doubt in the mechanic's mind as to the suitability of the bearing for further use, it is held for examination by test department representative, who makes the final decision as to whether the bearing is usable or should be returned to the manufacturer for repairs.

All pinions are run through the degreaser and then sent to the adjacent room for magnafluxing. If no cracks are detected, the pinion is returned to the cleaning room where it is placed in a rack and held for application to the same motor. If cracks are found, the pinion is scrapped and a new pinion is applied to the motor after assembly.

Motor heads are micrometered and if within the limits, they are painted and sent to the other end of the shop where motors are assembled. If out of round or under size, the head is built up with welding and re-faced to the original size in a lathe or boring mill located opposite the cleaning room.

After leaving the cleaning room, the armature passes through the magnaflux test, where the shaft is magnafluxed, and if no defects are found, it is placed back on the portable stand and is meggered and tested with a Surge Comparitor. The operator of the Surge Comparitor can determine if the armature is open, partially shorted or grounded, and his inspection determines the repairs necessary. If defects are found in the armature shaft at the magnaflux, the shaft is replaced at the 600-ton press adjacent to this machine, after which it proceeds to the previously mentioned test.

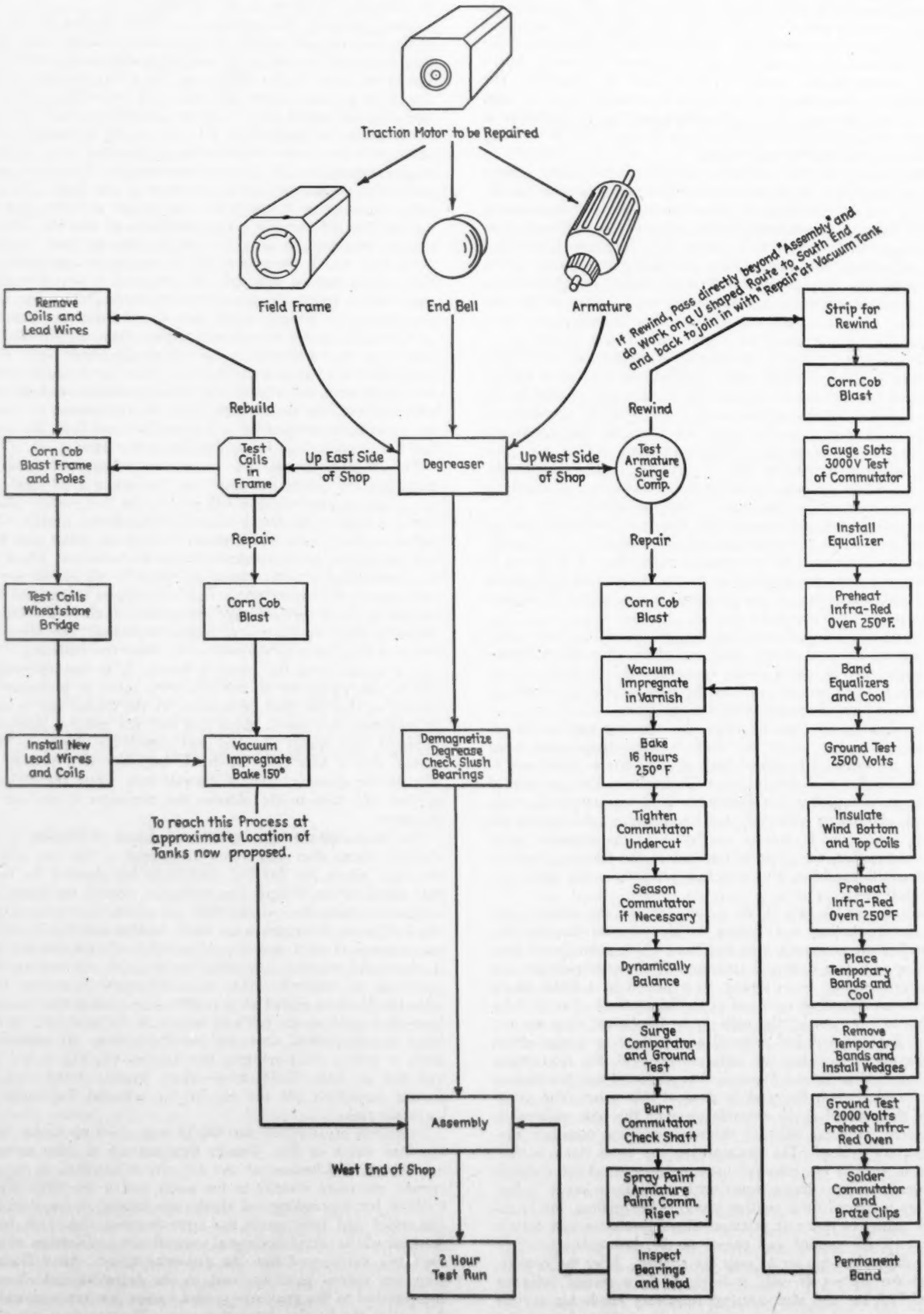
Armatures which pass O. K. are run around the various positions for rewinding and baking to the vacuum impregnator, where they are re-impregnated and from which point they follow the same path as a re-wound armature. If the tests indicate that the armature must be re-wound, it is placed in a lathe where the coils are cut off at each end of the laminations. Should it be possible to save any of the coils for re-insulation, they are not cut off, but removed and re-taped and pressed to proper shape for re-application. After the coils are removed, the laminations are blasted, cleaned, and file-dressed to gauge. If any laminations require replacement, the work is done at this point. The armature is then moved on its portable stand to the next position in line where insulation back of the risers and the equalizer connections are applied. The armature on the same stand is then placed in an 8.75 kw. infra-red oven and heated. After removal, the equalizers are drawn down with temporary bands before armature is placed on a cooling stand. After cooling, the armature is moved to the next position, where insulation and bottom set of coils are applied and passed to the next position, where the insulation and top set of coils are applied. After the installation of the top set of coils, it is placed in a second infra-red oven of 17.5 kw. and after heating, temporary bands are applied over steel bars placed on the coils to draw them down. The armature is next moved to a second cooling stand and after cooling, top sticks are applied, and it is then heated a third time in a 26.25 kw. infra-red oven to a temperature suitable for soldering the risers in the soldering pot.

After soldering, the armatures requiring brazing of the coils at the rear end are moved to the brazing machine, after which they are banded in one of the banding machines adjacent thereto. The string band is also applied at this time. Armature is then placed in a lathe, where the coil ends projecting beyond the riser face are turned off. If it is an armature on which the commutator requires seasoning, it then goes to the seasoning machine adjacent to the vacuum impregnator. If seasoning is not required, it goes directly to the vacuum impregnator. This impregnator tank holds six traction motor armatures at one time. The armatures are placed in the tank and the vacuum pulled on the tank and held for 30 minutes before admission of varnish. The vacuum is then used to draw the varnish into the tank to proper level, after which pressure of 80 lb. per sq. in., obtained with CO_2 gas, is applied and held for 1½ to 2 hours. Pressure is then used to return the varnish to the storage tank, after which the pressure is released, tank opened and armatures permitted to drain 30 minutes to one hour before they are removed and placed on the carts used in the electrically-heated bake ovens, where they are baked from eight to twelve hours. After coming out of the oven, the armature is cooled, undercut, and dynamically balanced. At the next position, the commutator is dressed up, given its final checking and inspection, and if O. K., moved into the assembly line for application to the frame.

The assembly line for traction motors is being set up on the basis that the pinion end head and bushing will be applied to the armature, after which it will go to a jig that permits placing the armature in the frame when in a horizontal position. This jig has a long center which passes through the frame and holds one end of the armature shaft. When the armature, which has been assembled with the pinion end head, is placed between the two centers, the frame which has been placed around the long centers is rolled forward over the armature, where the head is drawn to place by the use of impact wrenches. The assembled motor is then lifted to the test rack, where the commutator end cap is applied and the motor is tested. It is first operated at 600 to 700 r.p.m. for 30 minutes, then speed is gradually advanced so that the final 30 minutes of the 2-hour run is made at maximum safe speed. After this test, the motor is meggered, hi-potted, and finally checked and closed for shipment, being moved with a fork type lift truck from the west end of the shop to the cleaning room at the east end, where the pinion is applied and then to the elevator for movement to the car for shipment.

The frames go through a similar operation of cleaning in the cleaning room, after which they are moved to the east side of the shop, where the physical dimensions are checked for being true and accurate. If such dimensions are correct, the frame will continue in this line, where field connectors are untaped and checked to see if terminals are loose, brushes and brush holders are removed, cleaned, and re-applied, field coils are checked and if necessary, removed and either re-insulated and vacuum impregnated or renewed. When it is necessary to remove field coils, the frame is placed on a revolving jig so that the coils can be worked upon in any position desired by the operator. As the frame is re-assembled, necessary painting is done. An attempt is made to refrain from applying any brushes which it is not felt will run at least 25,000 miles—short brushes being sent to Juniata inspection pit for use in the terminal inspection of mountain pushers.

Generators are received for 400,000-mile check-up or for damage from wreck or fire. Usually they are not as dirty as traction motors, and because of the difficulty of handling in the degreaser, are taken directly to the south end of the shop, where facilities for dismantling and repairs are located. Generators are dismantled and built up in the same location. Jigs have been provided which permit horizontal removal and replacement of the armatures out of and into the generator frame. After dismantling, the various parts are sent to the degreaser and cleaned and returned to the generator section except the bearings, which are sent to the bearing inspection room. The armature is tested on a Surge Comparitor and if not necessary to re-wind, it is


Traction Motor to be Repaired
Field Frame
End Bell
Armature
Remove Coils and Lead Wires
Rebuild
Corn Cob Blast Frame and Poles
Test Coils in Frame
Up East Side of Shop
Degreaser
Up West Side of Shop
Repair
Test Coils Wheatstone Bridge
Corn Cob Blast
Install New Lead Wires and Coils
Vacuum Impregnate Bake 150°
To reach this Process at approximate Location of Tanks now proposed.
Demagnetize Degrease Check Slush Bearings
Assembly
West End of Shop
2 Hour Test Run
If Rewind, Pass directly beyond "Assembly" and do Work on a U shaped Route to South End and back to join in with "Repair" at Vacuum Tank
Rewind
Test Armature Surge Comp.
Repair
Corn Cob Blast
Vacuum Impregnate in Varnish
Bake 16 Hours 250° F
Tighten Commutator Undercut
Season Commutator if Necessary
Dynamically Balance
Surge Comparator and Ground Test
Burr Commutator Check Shaft
Spray Paint Armature Paint Comm. Riser
Inspect Bearings and Head
Strip for Rewind
Corn Cob Blast
Gauge Slots 3000 V Test of Commutator
Install Equalizer
Preheat Infra-Red Oven 250°F.
Band Equalizers and Cool
Ground Test 2500 Volts
Insulate Wind Bottom and Top Coils
Preheat Infra-Red Oven 250°F
Place Temporary Bands and Cool
Remove Temporary Bands and Install Wedges
Ground Test 2000 Volts Preheat Infra-Red Oven
Solder Commutator and Braze Clips
Permanent Band

Diesel shop traction motor flow sheet

undercut and dressed. Wire and string bands are examined and renewed where necessary, after which the armature is sprayed with a glyptal base red insulating enamel. All brush holders are removed from the frame, field connections opened for checking, and both main and interpole fields meggered and hi-potted. Such field coils as may require renewal are removed. Coils which may be repaired in the shop are repaired and impregnated and placed in line for re-use.

Since it is not possible to operate the generator in the Diesel Shop, it is moved directly out of the shop.

Auxiliary apparatus repairs, handled on the third floor, occupy approximately one-half of the floor space. The storeroom, also located on this floor, occupies approximately one-quarter of the floor space. The south end of this floor has been fitted up with benches, cleaning tanks, testing apparatus, small bake ovens, various test panels, hydraulic and air pressure lines, so that all types of switches and small motors may be tested and repaired. Small armatures used in miscellaneous motors are re-wound in this location. All the necessary facilities are available for the complete repair and testing of the various types of miscellaneous electrical apparatus used on the Diesel locomotives, so that, when the repairs are completed, the items are sent direct to the storehouse.

The shop is lighted with high bay mercury and incandescent lights. Side walls and ceilings are painted aluminum, floor red, with white safety lines, and all lifting devices orange. The shop was planned for a monthly output of 152 traction motors, 25 of which would be re-winds, and 25 generators, one of which would be a re-wind. At present, the working force is 72 men, divided between the two shifts. There is one supervisor on each shift following the actual repair work, and there is an additional supervisor on the first shift who follows the movement of the motors and generators and miscellaneous apparatus into and out of the shop, and sees that the necessary material is on hand when needed at the proper location.

The attached sketch shows the flow of the pieces through the shop.

Load Testing of Diesel Traction Motors

It is extremely important in the overhaul of Diesel traction motors that they be thoroughly tested upon completion of the work to locate any defects or faults which might result in a failure in service. A road failure of a traction motor is a serious matter since it results in delays to important freight and passenger movements.

Standard maintenance procedures in railroad traction motor repair shops and in service shops provide for frequent electrical and mechanical tests and checks to insure satisfactory workmanship and to detect any faults.

The armature, during basic or mileage overhaul is cleaned and inspected for broken parts, loose wire or string bands, loose wedges, cracked, charred or dry insulation, commutator condition, tolerance and wear on various parts. Electrical tests include measurement of insulation resistance, high potential tests and bar to bar resistance tests which should effectively locate any fault or unusual condition.

The field frame is likewise tested thoroughly to insure that all machined surfaces are within allowable tolerance and electrical measurements made of main and interpole field circuits. A comparison of the measured and computed resistances provides an accurate check of the material and workmanship, as well as conductivity of soldered or brazed joints and helps to detect high resistance or shorted coils. A Megger test is made to check condition of insulation.

The testing procedure includes an armature bearing run with the motor operating light at approximately 1500 r.p.m. for two hours. A source of direct current at 125 volts with a capacity of 50 amperes per motor is requried for this bearing run test. Temperature readings of the bearings are taken every 15 minutes during the run and frequent checks are made for noise and vibration which would indicate faulty assembly, dirty bearings or armature unbalance. The tightness of oil bearing seals is also checked and a visual inspection is made at completion of the run of string bands, cement filler, etc. The armature and field frame are then given a final high potential test after which the motor is ready to be returned to service.

There has been considerable discussion as to the need for load testing Diesel locomotive traction motors in a repair shop after the armature has been rewound. A questionnaire was sent to leading railroads who repair their own traction motors. Only a few railroads advised that they made such a load test with the percentage of failures found being very small.

Manufacturers of electrical equipment will normally run a complete set of tests on a motor only when it is of new design. These tests are usually called Engineering Tests and include resistance measurements, core loss curve, friction and windage losses, brush friction, speed regulation and a full load temperature test. The results provide design data, check calculations and confirm ratings.

Standard shop tests, similar to those outlined for traction motor overhaul, are given production line motors and normally none of these motors will be tested under load. After the original design and performance data has been secured there seems to be very little to be gained by routine load tests on every motor. In fact, unusual bearing conditions can be detected quicker and more positively when the motor is running light rather than under load. Maximum and minimum temperature limits, determined for bearing temperature rise under the no load run, also give positive information as to bearing condition.

One method of simulating full load conditions on a traction motor for test purposes consists of separately exciting the main field circuit with a high amperage low voltage supply from a motor generator set and then to impress a voltage of 1000 to 1400 volts on the armature as it reaches its maximum speed. The armature current in such case will be approximately 15 to 30 amperes. This method effectively tests the turn to turn armature insulation at maximum centrifugal force, gives a check of main field connections and at the same time permits bearing temperature run and vibration checks. There is no need to bolt the motor on a special stand.

A somewhat similar test can be made by separately exciting the main field circuit by a welding set or other source of high amperage, low voltage direct current and driving the armature by means of another motor. The traction motor under test acts as a generator and its speed is increased until desired voltage is obtained on the armature. This test necessitates a stand or base to support the motor under test, a relatively large driving motor and a source of direct current energy.

An actual full load test would require a tess stand with a generator of adequate capacity to act as a load, a means of absorbing the energy output of the generator and a motor generator set to supply the full load current and voltage of the traction motor. These facilities would be rather large, high in first cost, expensive to operate and involve considerable set up time.

It is evident that defects or weaknesses will be detected if routine electrical and mechanical tests are made as the armature is rewound and the frame progressed through the repair shop. A load test adds considerably to the cost of overhaul and one additional day to the overhaul time without producting definite results to justify the expenditure in time and money.

High Frequency Testing of Traction Motor Armatures

The overhauling and repairing of traction motors, generators and other allied rotating electrical apparatus used on Diesel locomotives can be performed by railroads in their own shops. Such repairs can be justified only if they can be handled more economically than if done outside or if the work results in increased mileage or service life between shoppings.

The repairing of this equipment, particularly traction motors, has become very competitive and in order to compete with outside repair shops it is essential that labor saving tools and testing equipment be provided in the repair shop.

One of the most essential pieces of equipment will be some means of determining how much insulation or mileage still remains in the winding, not particularly the total mileage remaining, but whether the winding will operate until due for another mileage overhaul. The amount of ground insulation can be determined by a di-electric (hi-pot) test or a megohmeter, but some other method of test is necessary to determine the condition of insulation between turns.

One of the methods by which this condition can be determined is by use of high frequency test apparatus. One electrical manufacturer developed such a machine for its own use in 1926 but hesitated to offer it for sale because of the many complicated adjustments necessary when changing from one type of apparatus to another. This machine was a spark gap type high frequency voltage unit for testing various types of rotating apparatus. It is capable of impressing between 800 volts to 10 kilovolts at a frequency of 180 kilocycles on the part being tested. Because of limited demand such a machine was specially built and consequently the cost was high.

The need for such a machine in a traction motor repair shop was first indicated when motors would fail on short mileage soon after being overhauled or even before shipment just after being progressed through the shop. Load testing of motors was tried but the number of failures developed by this test was so small that it was discontinued. The load test only indicated the condition of the motor at the time the test was applied, which was no assurance that it would not fail on the first trip after being placed in service. It does not give any indication of the amount of additional mileage remaining in the insulation.

The electrical manufacturer had experience with this equipment only in production testing of new equipment to find faults in the windings and they were hesitant to sell the machine for testing to determine amount of insulation remaining in winding. One of these machines was finally purchased and several years were required to collect and record sufficient data to establish values which would determine whether the armature under test would operate without insulation failure for another mileage period.

The large electrical manufacturing companies are now convinced that a machine of this type has a definite place in a repair shop such as is required in railroad work. They have produced a new design, called the Surge Comparison Tester which will be considerably lower in first cost than the high frequency tester.

The surge tester will charge two circuits or parallel paths in the winding at the same time. The discharge waves will show an oscilloscope screen as one irregular wave, but in reality it consists of one wave on top of the other, provided the conditions in the two circuits are similar. If the two circuits are not exactly the same, two dissimilar waves will be observed which indicates that one circuit is at fault.

By establishing certain current and voltage values, the machine can also be tested to test the condition of the insulation left in a winding, which can be transposed to equal mileage. The values to be used will have to be established by each individual railroad to correspond to such variables as climate, terrain, mileage expected between shoppings, tonnage, train speeds, etc.

Several years of testing were required to establish correct values to be expected between change-outs. With the manufacturers of the equipment now convinced that the results to be obtained are worth while, there is no reason why every railroad operating a repair shop cannot justify the purchase of such a machine. Now that the actual laboratory work has been completed and test results checked, these machines will be available and every railroad doing repair work on rotating apparatus should not attempt to set up a repair shop without provisions for a test of this sort.

The individual railroad is interested in increasing mileage between changeout of traction motors and the elimination of road failures. A tester of this type will be invaluable in helping to accomplish these results. It will not of itself eliminate failures, but with the proper personnel will be a valuable tool.

The outside repair shops now engaged in repairing traction motors, whether operated by the original manufacturers or independents, are guaranteeing 100,000 miles service. If a motor overhauled by one of these shops fails between the end of the guarantee period and the established mileage nothing much can be done about it. However, serious complaints are received from railroad managements if a motor overhauled in the railroad shop fails under such conditions.

The tests made with a high frequency test machine should go a long way toward eliminating insulation failures between shopping periods.

The report is signed by R. H. Herman (*chairman*, Joint Committee, and *chairman*, Electrical Section, Mechanical Division), engineer shops and equipment, Southern; A. P. Dunn (*chairman*, Electrical Section, Engineering Division), electrical supervisor, New York Central; G. O. Moores, assistant engineer, construction and maintenance, Baltimore & Ohio; C. F. Steinbrink, electrical foreman, Chicago, Rock Island & Pacific; J. W. Horine, Jr., assistant electrical engineer, Pennsylvania; J. O. Fraker, general electrical and Diesel supervisor, Texas and Pacific; and H. E. Preston, power supervisor, Illinois Central.

Discussion

The report was presented by R. H. Herman (Southern) who, in turn, called on A. P. Dunn (N. Y. C.), to present the section on turntables. Mr. Herman said that while turntables generally are going out of the picture, a number of round houses have been re-equipped and are being used for Diesels. The Pennsylvania shop, he said, is especially worth while visiting for anyone who has to do with such shops. Commenting on the committee's work, he said the members generally were of the opinion that load testing for overhauled motors is not advantageous—that it is generally better suited to obtaining characteristics of new machines.

C. F. Steinbrink (C., R. I. & P.) concurred, saying it does not give any indication of how much life is left in a motor.

R. I. Fort (I. C.) said his road is using the tester described in the report. It does not, he said, definitely check armature insulation and added, "I would like to load test motors, but realize the difficulties involved and if any other test proves to be adequate, I shall be willing to give up the idea."

The section of the report on high-frequency testing was presented by C. F. Steinbrink (C., R. I. & P.). He said that efforts had been made to find some way of determining the mileage left in insulation, and that while it had taken several years to convince the Westinghouse Electric Corporation that a high-frequency tester should be built, and several more to learn how to use it, they have cut down road failures at least 75 per cent, and have increased those which occur in the shop. Referring to the surge tester, he said, that the Westinghouse representatives doubt if this machine will show how much life is left in insulation, and that it will take some time to find out.

Referring to a new set of circumstances, Mr. Steinbrink said that his road had been getting 750,000 miles service on motor insulation, and that since the introduction of silicone, his shop has practically lost control of rewinds. Maximum mileage now, he said is 186,000, and the average not more than 100,000. He has, he said, tried to discourage the manufacturers from using silicone until more is known about it. If the present situation is allowed to exist, he thinks it will wreck the reputation of the Diesel by making maintenance costs too high. Something, he said must be done to correct the situation.

W. S. Heath (A. T. & S. F.) asked if surge testing had caused any field break-downs, and Mr. Steinbrink replied that he had no conclusive evidence. Mr. Heath then asked how armature "A" is compared with armature "B," and Mr. Steinbrink replied that in looking at the oscilloscope, there is only one curve if the coils are okay, and it provides no means of comparing one armature with another.

Mr. Heath suggested that the difficulties described by Mr. Steinbrink may have been caused by overloading. Mr. Steinbrink replied that on some D-7 motors in passenger service, his road is getting better performance than with D-27 motors. He added that his shop intended to eliminate the use of silicone coils.

Mr. Herman said the Southern has been using silicone coils for several years with little difficulty on armatures which they have repaired in their own shop. He added that they had experienced a high rate of failures on D-27 motors.

Mr. Heath asked if high frequency tests tended to weaken insulation, and Mr. Steinbrink said that it is just a means of picking out bad insulation.

J. E. Marti (I. C.) asked for information on the seasoning of commutators. Mr. Herman said that seasoning is an absolute necessity for a rebuilt commutator, but that in his opinion there was some question concerning its need as a part of general overhaul.

Mr. Hamilton (N. Y. C.) asked if V-rings are pulled up when motors are overhauled, and Mr. Steinbrink replied that it was done in his shop at first, but that the practice distorted the

rings, and was discontinued. He added, however, that it was absolutely necessary when an armature has been rewound. The overhauled armatures are spun, but not seasoned, unless necessary. Mr. Heath (A. T. & S. F.) added that it is difficult to know definitely the temperature of a commutator when convection heating is used.

At the request of the chairman, J. W. Teker (General Electric Company) responded to some of the questions which had been raised. He said it was particularly interesting to listen to comments offered by railroad men since the manufacturer has perhaps four hours experience with his own product, while the user may have twenty years. He described the construction of commutators. A high bar, he said, will break brushes, and seasoning positions bars so they will not move in service. Seasoning, he explained, can be done out of the frame, or on the motors own bearings and, in any case, the armature must be brought to operating temperature. He said that if an armature is dropped or resoldered, it should be heated, brought up to speed, checked, pressed, heated and run until stable. He recommended contact type pyrometers for measuring commutator temperatures, saying that thermometers are slow.

Asked by the chairman, what temperatures are used for seasoning, Mr. Teker said, "We use 160 deg. C. on traction motors." He added that the commutator is brought to the required temperature, held one hour and cooled—this cycle being repeated three times. A commutator, he said, is only tightened when it fails to respond.

Mr. Teker was asked what hardness was considered good for commutator copper, and he replied that it is G. E. practice to use a scleroscope hardness of 20, and that if a hardness between 10 and 15 is found, it is not considered good.

W. I. Johnson (L. & N) asked Mr. Teker for information on silicone insulation and Mr. Teker replied that their own (G. E.) silicone coils have so far been in service for only 750,000 miles, and do not yet afford a basis of comparison. He added that there is no magic in silicone—that it does not prevent all motor troubles. Good construction, he said, is necessary, because vibration wears out insulation, and if a winding is not held securely, it will wear out. Silicones, he concluded, hold a lot of promise, and we are putting out sample motors, but more time and testing is necessary.

Electric Heating

The first section of the report describes a new installation of track switch heaters, and covers tests made on the heaters. All of this part of the report is included in the following, except for curves showing distribution of temperature and rate of temperature rise in the rails. The latter part of the report includes comments respectively on Conductive Rubber, used originally as a static dissipator and more recently as step tread deicers, walkway and ramp tread material; Glass Panel Heating, used for interior heating, windshield defrosting, etc., and Paving Heating in which conducting material is cast in concrete to form a heating element for snow and ice removal.

Electric Track Switch Heater (Snow Melter) Installations at Cumberland, Md., and Willard, Ohio

An installation of electric track switch heaters was completed during the winter season of 1948-1949 by the Baltimore and Ohio Railroad in its large classification yards at Cumberland, Md., and Willard, Ohio. These heaters are to protect and insure operation of the remote-controlled track switches in these yards during winter weather and when required. There are 40 heaters varying in length from 10 ft. to 17 ft. 6 in. installed at Cumberland, and 112 heaters varying in length from 12 ft. to 17 ft. 6 in. at Willard.

The heaters are of the round, tubular sheath-type, flattened on two sides and fastened to the inside of the web of the rail directly under the head by steel clamps (See Fig. 1). The heater rating is 500 watts per foot at 460 volts. The effective heating length of the heaters is the same length as the switch point being protected, plus a non-heating section of 6 in. at each end to allow for bends and terminal connections.

The underground distribution from the safety switches to the heaters is stranded single-conductor cable, with type RW insulation of 600 volts, buried directly in the ground. Connection is made to the heater leads in a cast iron junction box mounted on a 4-in. diameter by 22-in. cast iron pedestal set in the ground, two boxes being installed at each track switch protected.

Heating leads between the junction boxes and the heaters are protected in rubber hose.

To provide proper clearance for the heater, it was necessary to grind approximately ¼ in. from the inside reinforcing bar of the switch point for a distance of about 30 in. At the heel end of the switch, where it was impossible to bring out the heater leads between the rail flanges due to the heel block, two methods were used. Where the heel block was installed, the web of the solid running rail was drilled to allow the lead to be brought out. Where the heel block had not as yet been installed, a groove for the lead was cut out in the flange and web of the block.

At Cumberland, 240/480-volt service is supplied the heaters through three 100 kva. single-phase transformers connected to the 2.3 kv., 3-phase, 60-cycle service supplying other facilities of the railroad. Fig. 2 shows a general view of this substation.

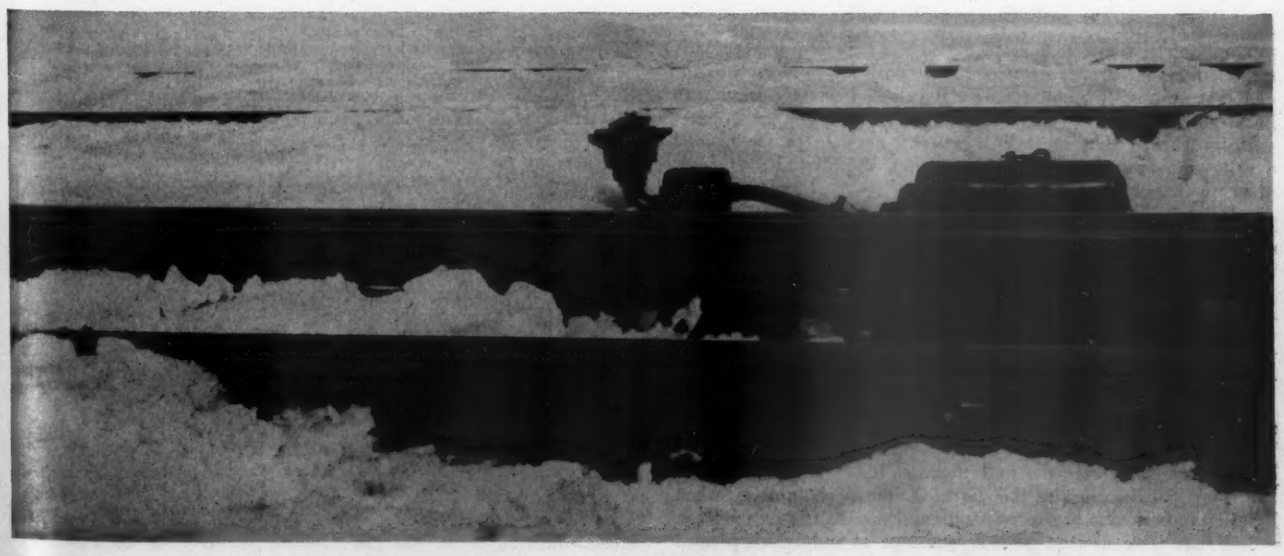


Fig. 1—View showing application of heaters to rail

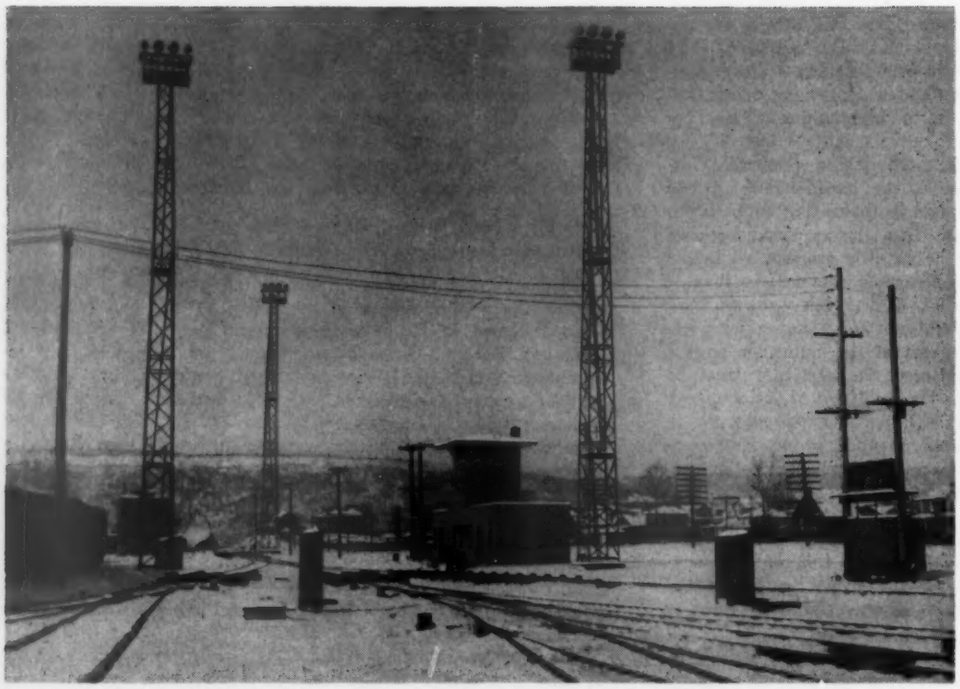


Fig. 2 — Substation at Cumberland, Md., showing transformer bank supplying switch heaters, at extreme right

At Willard, where two separate yards are involved, heater voltages are supplied from: the eastbound yard, three 200-kva. single-phase transformers; the westbound yard, three 100-kva. single-phase transformers. Primary voltage of 7.2/12.47 kv. is supplied from the general yard distribution system.

Two-pole, double throw safety switches were installed to secure the desired 480-volt (full-high heat) or 240-volt (¼ low heat) to the heaters.

Heater circuits are limited to 200 amp. and are controlled by two-pole single-throw fused safety switches. These switches are all contained within a weatherproof box mounted at the transformers, as shown on Fig. 3.

Two indicator lights, one burning for low heat and both burning for high heat, are installed at a visible location to inform the operator in the tower of the degree of heat being applied to the heaters (See Fig. 4).

During the winter season of 1949-1950 the cost of current per switch point per hour averaged 2.9 cents at Cumberland, Md., and 3.4 cents at Willard, Ohio.

Rail Temperatures with Electric Switch Heaters

The preferred rail temperature and the temperatures actually obtained when using electric heaters are of interest to the end that eventually a more practical value of wattage input can be established.

It is believed that in time it will be possible to recommend a rail temperature; for instance 60, 100, 215 deg. F., or some other temperature.

Rail Temperature Tests in Connection with Tubular-Type Snow Melters

In connection with the study of preferred rail temperatures when using electric switch heaters or snow melters, some findings and observations as reported from tests in the Cleveland Union Terminal, when the snow melter installation for that terminal was being studied, are herewith presented.

After careful consideration open-flame heaters were ruled out for the following reasons:

1. Possible injury to the wiring of the electric locomotives should they stand over the open flame.
2. Possible hazards in the form of personal injuries when lighting burners, due to silent operation of the electric locomotives.
3. If gas were used, a possible shortage of supply when most needed due to increased factory and domestic use.
4. If oil were used, the fire hazard incident to the storage of large quantities of oil to meet winter requirements would be objectionable.
5. If oil pots were used, the hazard mentioned in connection with oil would obtain and, further, smoke from the burners would obscure signals and signal indications.

These tests covered the agencies for melting snow with the exception of steam or electricity. Steam was discarded because of the fact that it would require carrying practically a full head to insure that heat would be available when required; also, it would be undesirable due to the fact that escaping steam would obscure signals and their indications.

Having exhausted all other means for melting snow, there remained only electricity as a means to generate the necessary supply of heat.

Many tests were conducted with tubular heaters in various positions on the stock rail, such as at the base of rail, the center of the space between the base and head of rail and underneath the head, but the position which proved most favorable from a

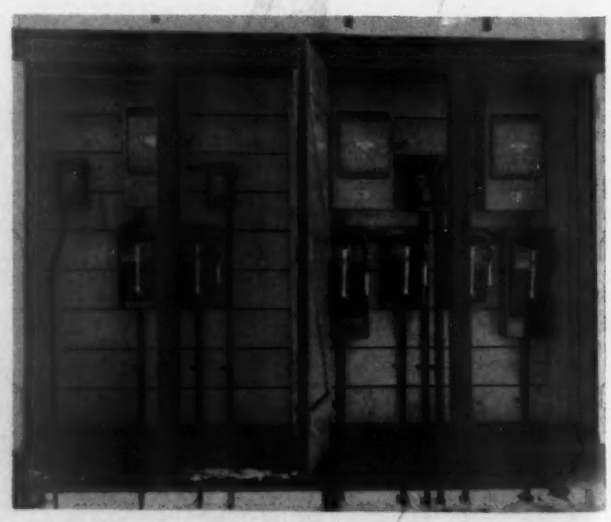


Fig. 3—Interior view of weatherproof safety switch cabinet

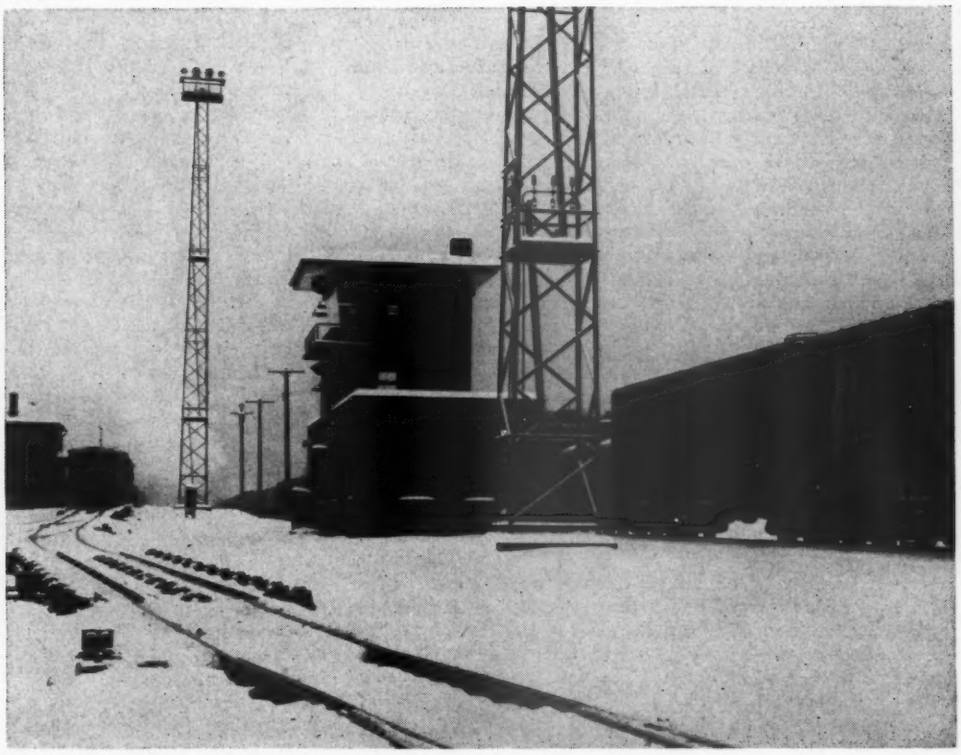


Fig. 4—View showing indicator lights on floodlight tower just above first platform

heat distribution standpoint, was the center of the space between the base and top of the rail.

With the heaters tested, it was found that the increase in temperature was at the rate of about 25 deg. for each 15-minute period up to the first hour and thirty minutes, when the curve gradually flattened out to the end of the fifth hour, having reached a temperature of 185 deg. F. The acceleration was practically constant, whether the tests were made at atmospheric temperature or in cold storage room, that is, the curves for ambients of +60 deg. F. and +O deg. were practically parallel.

The report was signed by C. A. Williamson (*chairman*), electrical engineer; R. C. Welsh, Jr. (*vice-chairman*), general foreman, office of electrical engineer, Pennsylvania; H. C. Cross, general foreman, Baltimore & Ohio Chicago Terminal; E. B. Hager, assistant engineer, Illinois Central; V. R. Hasty, electrical engineer, Union Pacific; A. L. Kelly, electrical engineer, Missouri Pacific; C. S. Stringfellow, assistant to electrical engineer, Atlantic Coast Line; E. H. Werner, assistant electrical engineer, and R. P. Winton, testing engineer, m. w., Norfolk & Western.

Discussion

The above report was presented at the opening of the Tuesday morning, September 19, meeting with Chairman of the Engineering Section S. R. Negley presiding. The report was presented by C. A. Williamson (T. & N. O.) and E. B. Hager (I. C.) and H. C. Cross (B. & O. C. T.). Mr. Negley asked if the committee had made any attempt to correlate wind velocities in making its tests, and Mr. Hager replied this will be covered in a general way by tests made in various weather zones. He also said that in most cases the high-heat will apparently not be necessary. Too much heat, he said, is to be avoided since it may dry up the oil on the switches.

Following the presentation, the section of the report on glass panel heating, H. Duehne (N. Y. C.) said that the New York Central now has 100 m.u. cars with panel heating for the motorman's window. He said that a power consumption of 180 watts in 4 sq. ft. of the glass would raise the temperature from 75 to 130 deg. F. Mr. Cross said that the stannic oxide, used on the surface of the glass as a conductor, can be applied in various thicknesses up to 0.00002 in. before it interferes with visibility.

Welding and Cutting

The report of the Committee on Welding and Cutting, the largest of all the reports, includes 230 pages, covering a revision of Section F of the Manual on recommended practice. It represents work which has taken two years to complete. It covers Gases and Equipment; Oxy-Acetylene Flame Cutting; Oxycetylene Welding; Other Uses of the Acetylene Flame; Metallurgy of Arc Welding; Arc Welding Equipment; Electrodes; Metallic Arc Welding; Semi-Automatic Welding Equipment; Special Arc Processes; Hard Surfacing With the Electric Arc; Testing Welds and Qualifying Welding Operators; Resistance Welding; Brazing With Silver Alloys; Welding White Metal Alloys.

The report was signed by L. E. Grant (*chairman*), engineer of tests, Chicago, Milwaukee, St. Paul & Pacific; J. Michne, welding instructor, New York Central; Frank Hayes, general foreman, Illinois Central; M. A. Herzog, chief chemist, St. Louis-San Francisco; Frank A. Longo, general boiler inspector, Southern Pacific; B. G. Wollard, welding instructor, Chicago & Northwestern; John Hengstler, supervisor of welding, Pennsylvania; H. A. Patterson, supervisor of welding, Atchison, Topeka & Santa Fe; C. A. Williamson, electrical engineer, Texas and New Orleans; and R. P. Winton, testing engineer, maintenance of way equipment, Norfolk and Western.

Discussion

The report was presented by L. E. Grant (C. M. St. P. & P.) J. Leisenring (I. C.) congratulated the committee on its work. He asked if copies of the report might be obtained for wider distribution, and Mr. Grant replied in the affirmative.

Car Electrical Equipment

In response to its assignment No. 1, on car power supply and generator drives, the committee reports there has been no new development.

Covering its assignment No. 2 on Diesel-engine-driven generator sets for passenger car power supply, the committee reports as follows:

As a result of the various experimental installations of the

under-car Diesel power plant, a number of changes and developments have been made. However, none of these changes and developments have been of such nature as to make any radical difference in the fundamental design of these units.

However, as of this time, it is quite likely that any large number of Diesel alternator (220-volt, three-phase, 60 cycles) units will not be installed except on new cars undergoing construction but there has entered the field a unique Diesel unit and that is the Diesel unit driving a d.c. generator, which will permit of Diesel installations on older equipment without changes in the wiring and motor equipment of the present d.c. equipped cars. This type of installation is being received with favor. There are at least 50 of such Diesel d.c. units on order and in service at the present time. In addition, with the experimental units in service, there are probably about 40 Diesel alternator units (220-volt, three-phase, 60 cycles) in operation at the present time.

All railroads using either the d.c. or the a.c. Diesels report performance satisfactory or acceptable.

The scheme of synchronizing two or more of these units, which was recommended in previous reports, has now been successfully demonstrated. The General Electric Company report that they are running 14 such Diesel alternators in parallel continuously on the G. E. exhibition train and that the loads on the units divide satisfactorily.

It is of interest to note a further report made concerning the G. E. exhibition train and that is the overhead electric heat was used exclusively for heating while the exhibits were being installed, also, that the cars were not uncomfortable at a temperature outside of ten below zero. The train was setting outside but not in motion

From the information available at the present time, it is indicated that the under-car Diesel generator offers a satisfactory means of supplying power independent of the movement of the train and without requiring high capacity yard power for standby purposes.

Cost and performance data of units in service previously reported in 1948 and 1949 are relatively the same for 1950.

Concerning its assignment No. 3, on caboose power supply, the committee reported no new developments, but a considerable increase in the number of applications.

Assignment No. 8, on jumpers for brake lines, brought out the following:

Investigation reveals that while the dimension of HSC brake cable jumper shown as 47 in. overall in the Manual is definitely too short, there seems to be no general agreement on what this dimension should be. It varies with different railroads from 50 in. to 69 in. overall length. The main difference for this variation arises from the fact that the location of the HSC brake jumper receptacle varies from that shown in the manual and, further, that the six contact receptacle shown in the manual is not universally used; the twelve contact and the eight contact receptacles are still in rather widespread use. It is recommended, *as a letter ballot proposition*, that the last paragraph on page ES-A-18-1945 of Section 2 of the manual, reading "Completed jumper between cars to be 47 in. overall length in." be completely eliminated and no substitute made therefor until such time as the committee can determine a more positive agreement between railroads.

This section of the report also recommends a modification of the brake jumper receptacle, namely, that a dimension of 1/16 in. be shown between the end of the contact and inside face of the outer insulation shell.

The committee's assignment No. 4, to study and report on power supply, including requirements for electric cooking on diners, begins with a description of the Pennsylvania's twin-unit diner.

This was described in the May, 1950, issue of *Railway Mechanical and Electrical Engineer*. Also included are a description of the requirements of electronic cooking, and tables of connected loads for both the two-unit diner, and a single-unit diner. These items have also been covered in this magazine.

The need for derating fuses and circuit breakers because of high temperatures in electric lockers has concerned the committee for some time and, in conclusion of its report on its assignment No. 5, the committee offers the following recommendations.

It is quite apparent that the most feasible and efficient method of keeping temperatures within reasonable limits in the apparatus locker is forced ventilation by means of exhaust fans which will remove the excess heat and discharge it outside the car rather than to the car interior as the latter imposes an unnecessary parasite load on the air-conditioning equipment.

A combination installation of an exhaust fan discharging to outdoors through an exhaust ventilator may be installed. However, definite data should be obtained from the manufacturers concerned to indicate the actual cu. ft. per min. discharge with the car standing or running up to maximum speeds expected to be reached in service. This is an important feature in order to be assured of adequate exhaust when car is standing yet not too much at high speeds as to result in drawing out not only excess heat but the cool air from the car body as well.

There are several methods of connecting exhaust fans, some of which are as follows:

(a) In the case of motor-generator type of power plant, the fan may be so connected that it cuts in and out automatically with the generator.
(b) It may be so connected that it operates only when the load regulators are in operation.
(c) It may be connected to operate under control of the main load switch.
(d) It may be connected to operate under control of the blower fan switch.

The method to be used depends on the conditions under which the excess heat is present and may vary to suit the particular car or operating conditions.

The cu. ft. per min. handled by the fan should be at least 200 where there is a single locker containing all the heat generating equipment. There should also be an adequate intake grille in the locker enclosure so located that the air drawn in shall pass across the major pieces of equipment in the locker.

The above installation will remove the excess heat as quickly as is released and will result in minimum locker temperatures with consequent gain in operating efficiency of equipment adversely affected by high temperatures.

On the question of hinged vent caps for storage batteries (assignment No. 7), the report states:

Some difficulty has been experienced due to certain of the personnel not being familiar with this type cap and, thinking it was a screw type, broke the ears which hold the hinged cap in place. Other reports are that it is very easy for dirt to get under certain of these caps preventing them from closing properly.

The Committee recommends the manufacturers design the seat and cap to a bevel fit with the cap designed to flange over the seat to prevent an accumulation of dirt.

The caps should be suitably weighted and balanced to close by normal vibration of a moving car. The hinge should be located on the left hand side, facing the battery container.

To obtain information on trainlining of cars (assignment No. 10), the committee sent out a questionnaire, and from the replies developed the following information:

All but one railroad reported having passenger cars equipped with trainline connections. A two-wire system is used in all cases and wire sizes vary from 2/0 to 300,000 c.m. Systems trainlined as 32-, 64- and 110-volt d.c. 220-volt a.c., 60-cycle, three-phase Diesel power plants for individual cars are paralleled by trainlining in some cases.

The per cent load carried by trainline connections varies from 50 to 100 per cent, but, in most cases, from 50 to 75 per cent of normal load of defective car.

(a) The capacity of trainline switches varies from 150 to 300 amp. and, in several instances, no switches are used.
(b) Trainline circuit breakers are not used generally; however, such breakers are being used on some railroads.

Several different types of two-wire trainline jumpers and receptacles are in use with current ranging from 100 to 250 amp. Jumper cables vary in size from No. 2 to 250,000 c.m. and in length from 45 in. to 55 in.

From the above, it can be readily observed that the committee should obtain further data on the connected loads for 32-, 64- and 110-volt d.c. and 110/220-volt a.c. systems, and the percentage of these loads that are trainlined.

It is suggested that this assignment be continued for further study.

Concerning the protection of overhead jumpers between cars (assignment No. 11), the report states:

Inquiries develop that nearly all roads are experiencing difficulty with certain types of holders, curtains or supports for these trainline wires. One of the latest methods, as applied to ten of the newest sleepers on the Baltimore & Ohio, consists of two metal plates, one anchored at the doorway, and the other anchored on the diaphragm face, and sliding over each other, covered on the top side with sheet rubber. This method has not been in service long enough to make any recommendations. It is suggested that this assignment be continued for further study.

Assignment No. 12 presents color codes for car wiring for d.c. fluorescent lamps, and for the development of standard markings for passenger car wire (assignment No. 6), the committee has collaborated in the preparation of the report submitted by the Committee on Automotive and Electric Rolling Stock.

The final section of the report (assignment No. 9) reports its progress on the preparation of specifications to cover the a.c. portion of motor-generator equipment.

The report was signed by S. B. Pennell (*chairman*), assistant engineer, New York Central; L. C. Bowes, electrical engineer, Chicago, Rock Island & Pacific; J. A. Bucy, electrical supervisor, Baltimore & Ohio; V. F. Dowden, engineer car electrical equipment, New York, New Haven & Hartford; J. E. Gardner, electrical engineer, Chicago, Burlington & Quincy; K. H. Gordon, assistant electrical engineer, Pennsylvania; R. A. Harrington, engineer train lighting, Chicago, Milwaukee, St. Paul & Pacific; W. L. Mon, chief inspector of train lighting and air conditioning, Canadian National; C. A. Pearman, electrical engineer, equipment, Illinois Central; J. W. Sharpley, train lighting engineer, Canadian Pacific; L. J. Verbarg, assistant to chief mechanical officer, Missouri Pacific; G. H. Wall, electrical foreman, Delaware, Lackawanna & Western; and A. H. Koch, inspector, Pullman Company.

Discussion

S. B. Pennell presented the report calling on sub-committee chairmen to present various sections. Assignments Nos. 1, 2 and 3 were presented by L. C. Bowes (C., R. I. & P.). He said the question of jumpers between cars is important—that on the Rock Island it is necessary to have cables of four different lengths. J. E. Gardner (C. B. & Q.) agreed that the 47-in. cable is too short, but said that at present the trouble could not be corrected without first settling other problems.

A. E. Voigt (A. T. & S. F.) asked how long the split gear (Excel) drive had been in service. G. S. Glaiber (N. Y. C.) replied that his road has passenger-baggage cars equipped with this drive, and that the drives have a service record of a million miles and have worked well. J. W. Sharpley (C. P.) said that his road had used them for three years on 7½-kw. drives without trouble.

Mr. Glaiber asked if anyone present had had operating experience with walkie-talkie communication in freight service in which the portable set is powered by storage batteries. W. S. Heath (A. T. & S. F.) said they are used in Santa Fe yards, and that the Willard batteries used are recharged every eight hours, and have a life of about six months.

W. J. Madden (P. R. R.) asked for information on the Spicer outboard drives used on New York Central baggage cars. W. S. H. Hamilton (N. Y. C.) replied that five more Spicer drives have been authorized. Applications were made in the spring of this year, and no trouble has been reported up to the present time. Two advantages, he said, are that the generator is accessible and that the drive may be removed without putting the car over the pit.

J. A. Bucy (B. & O.) was called upon to present assignments Nos. 4, 5, 7, 10, 11 and 12. W. E. Dunn (Electric Storage Battery Co.) was asked for information on hinged battery caps. He said they are particularly important for 110-volt batteries. He said a lead counterweight had been considered, but that the work had been started when material was scarce. Improved designs, he said, are forthcoming. Mr. Hamilton said that if the hinges are placed on the left-hand side, the cap will be relatively free of interference from cables and terminals.

A. E. Voigt wanted to know if magnetic circuit breakers might not be used in car lockers, since thermal breakers had to be derated because of high temperatures. G. W. Wall (D. L. & W.) said that the magnetic breakers might have possibilities, but that the committee's assignment did not include them. R. I. Fort (I. C.) said some tests have been made with magnetic breakers. Temperature, he said, has some effect on them, but not as much as it has on the thermal type.

A discussion of the desirability of trainlining of power circuits on passenger cars developed a considerable range of opinion. W. J. Madden (P. R. R.) said, "We do not have train-line trouble because we do not have train lines." Trainlining a car in trouble, he said, usually means two failures instead of one. A. E. Voigt said connectors are as important as the trainline itself. W. S. H. Hamilton said he believed about as Mr. Madden, and added that the New York Central has only diners equipped with trainlines. It is different, he said, with railroad-owned sleepers. Consider, he said, the failure of a generator on a sleeping car which might require transfer of passengers. Under such a circumstance, he said, it is highly desirable to keep blower and lights going. With only the blower going, the car is not good on a hot night, but, he added, it is much better than transferring passengers.

Mr. Madden explained that 110-volt systems are used on P. R. R. sleepers and that they also use both lead and Edison batteries which have different requirements.

A. L. Kelly (M. P.) approved of trainlining, saying the Missouri Pacific has enough generator capacity on two cars to take care of three. He said they had had failures of which the passengers had no knowledge. A. E. Voigt said that when a failed car is fed from both ends, objectionable voltage drop is avoided.

R. F. Dougherty (U. P.) said that with three voltages the situation is not only difficult for the cars, but also for supplying power to rear signal lights. He expressed the opinion that all roads should have 32-volt train lines.

J. R. Bucy (B. & O.) said it is often necessary to trainline through from a distant car. G. S. Glaiber (N. Y. C.) said the New York Central has a 64-volt trainline which can carry various voltages and that they have trainlined from the fourth car.

Concerning the use of different types of batteries, G. W. Wall (D. L. & W) said, the two batteries need not be kept together, and there is still enough power for everything on the second car except the compressor.

A. L. Kelly (M. P.) said his road uses 300,000 c.m. cables and that they have had two generators down in one train without an air conditioning failure. With a No. 2 trainline, he said, Edison batteries will be running low and lead batteries will be somewhat overcharged, but no great harm will be done.

J. A. Andreucetti (secretary emeritus) said there are two problems—one of emergency, and the other that of having to deal with different voltages during regular operation. J. R. Bucy said the committee has been primarily concerned with the problem of emergencies. He asked how many roads attempted to carry complete load through trainlines. A showing of hands disclosed the fact that 22 of the roads represented did, and 7 did not. L. H. Williamson (G. N.) said the Great Northern trainlines three cars together, when necessary, and obtains partial cooling.

G. S. Glaiber (N. Y. C.) referred to an article on standardization of cars published in the September, 1950, issue of *Railway Mechanical and Electrical Engineer*. Such standardization, he said, should include standardization of the electrical equipment. J. R. Bucy then asked if anyone had found adequate means of supporting jumpers between cars. L. H. Sultan (S. P.) said the Southern Pacific now has about 200 cars equipped with metal plates and canvas. Mr. Bucy said this is effective, but does not keep water from coming down. H. F. Reynolds (Budd Manufacturing Company) said Mr. Sultan represents the latest thinking on this subject. He added that the Budd engineering department (in view of the decline in passenger car building) is trying to standardize base car design. This has made it necessary to adopt a standard electrical system, and for this purpose, the 64-volt system has been selected.

F. Peronto (secretary, Mechanical Division, A.A.R.) said the A.A.R. has established a standards committee on passenger car specifications, and he expressed the opinion that it should include a representative of the Electrical Section. This he said, will be brought to the committee's attention.

Car Air Conditioning Equipment

On its first assignment, to report on new developments in air distribution systems, including dining-car-kitchen ventilation and air conditioning equipment, the Committee on Car Air Conditioning Equipment reports as follows:

Ventilation

Recently two railroads placed in service ten new conventional type dining cars each equipped with two separate air conditioning units, one for dining room and the other for kitchen.

The Great Northern diners are equipped with a 7-ton modulated cooling control air conditioning unit for the dining room and a separate 3-ton capacity full cycling evaporator for the kitchen. The two evaporators are independently controlled so that either or both can be in use without being affected by the other. The 10-ton compressor unit goes into the reduced or modulated speed whenever the total load of the two evaporators is under 6½ to 7 tons.

The kitchen air conditioning system is equipped with thermostatic control. A two-speed blower fan control is provided for ventilation and heating only; for cooling service one fan speed is used supplying 900 cu. ft. per min. of outside air and 300 cu. ft. per min. of air is taken from dining room; 1200 cu. ft. per min. of air is exhausted from the kitchen.

The New Haven diners are equipped with a 5-ton air conditioning unit, 1,800 cu. ft. per min. capacity for the dining room and passageway and a 3-ton evaporator for the kitchen. A single thermostat in body of car modulates both body of car and kitchen. The kitchen unit delivers 800 cu. ft. per min. all fresh air. The kitchen blower fan is equipped with electrical control so that when blower fan is shut off the evaporator solenoid valve is deenergized and only half of evaporator coil is in service. An ERV valve in the freon suction line holds the back pressure up on the 5-ton air conditioning unit when kitchen unit is shut down.

The Norfolk and Western recently placed in service twenty new 6-double bedroom 10-roomette sleepers incorporating a novel and new arrangement of air conditioning system.

There is a single manually adjusted thermostat in each room which controls both floor and overhead heat and in cooling season the same control is used for the individual room reheat for low temperature conditioned air. Change from heating to cooling or vice versa is automatic, based on the temperature of the air before it reaches the air conditioning unit. The control operates to close or open the main steam valves of the floor heat system and overhead radiator, and to start or stop the refrigerator compressor.

The air conditioning system is the electro-mechanical type, 7 ton capacity, maximum circulation of 1,600 cu. ft. per min. of air.

The air conditioning system circulates 100 per cent fresh air except under extreme weather conditions tending to overload the overhead heating radiator and cooling unit.

One railroad is now equipping the kitchen of several diners with the Gaylord range exhaust ventilator. The application consists of a duct extending lengthwise at rear of range containing horizontal baffles and a hinged trough below duct at entering end to collect condensed grease. The exhaust air is drawn by a conventional exhaust fan adjacent to exhaust ventilator in roof. The odor and grease laden air is drawn across the top of range carrying heat away from front side of range. As the air is drawn over the alternate staggered baffles, the heavier water and grease vapors are separated out by condensation and impingement, collecting in trough at bottom end of duct. The design has merit for elimination of grease deposits in exhaust ducts of kitchen and resultant fire hazard. No experience has yet been obtained to date.

On the New York Central a grease and lint eliminator has been developed for the exhaust duct of dining car kitchen ranges. With the conventional exhaust duct at rear side of range, a 2-in. thick dry metallic air filter has been installed at an angle from bottom side of warming oven above range top to rear closure of range, in order to provide filters of sufficient face area. At the rear and spaced above the filter a wire screen flame arrester is provided as an additional protection in case the grease filter should ignite. The performance of this application has been satisfactory in elimination of grease from exhaust duct and hazard of fire in duct.

Electronic Filters

The Committee's second assignment was to study electronic filters. On this subject, it has the following to offer:

At the present time, the larger number of cars equipped with electronic filters are using the Electro-Airmat dry type Precipitator. Since our last report both the N. & W. and the D. & R. G. W. have acquired cars using the Electro-Airmat. We have not as yet been able to learn what their experience has been with this equipment.

The Chesapeake and Ohio received 46 cars in the latter part of 1948 from the Budd Company. All of these cars came equipped with Electro-Airmats and Roto-Clone precleaners. Three of these cars were sold to the D. & R. G. W. during the year 1949. Forty of the remaining 43 cars have been in regular service since the fall of 1948. The performance of the Airmats on the C. & O. cars has been very good. Car interiors, including upholstery, have remained noticeably cleaner than on other cars equipped only with mechanical type filters. In no instance has trouble been experienced in cooling or heating the cars, due to increased resistance, as the filter media became loaded with dirt. Fiberglass media is used on the C. & O. in preference to paper media. Originally paper was used, however, the paper is inflammable and was considered a fire hazard, and was therefore discarded in favor of using the fiberglass. Both medias have comparable efficiencies when used in the Electro-Airmat.

It is standard practice with the car builders to design the ventilating system for a maximum resistance in the Electro-Airmat collector cell of .3 in. of water, and the collector media should be changed at this point. In numerous cases, samples of used media have been removed, after various periods of service, and submitted to the manufacturers of the Electro-Airmat for laboratory analysis. The results of these tests indicate that an average of 30 days' service might be expected out of the media, as used on the Chesapeake and Ohio.

Both fresh and recirculated air is passed through the Airmat on C. & O. cars, however, the life of the media is materially lengthened by the use of the Roto-Clone precleaner, which device is used for precleaning the incoming fresh air.

Material replacements except for ionizer wires, have been very low. Ionizer wires have had an average life of about 60 days. Power pack troubles have been almost non-existent and the maintenance has practically resolved itself into renewal of Airmat media and ionizer wires.

At the present time, the Pullman Company has approximately 100 sleeping cars equipped with the dry-type electronic air filters. These are being operated in sections of the country where unusual dust conditions are generally found.

Occasional renewal of the rectifier tubes has been the chief item of maintenance. One transformer with adjacent wiring burned up, but it was so badly damaged the cause of the difficulty could not be definitely located.

It was reported last year that fifteen days was the approximate life of the media. This varied with the type of service. In extremely dusty operating conditions, it is necessary to change the media more often to increase the performance of the cooling equipment.

It appears that an additional 12 to 18 months of service with this type of filter mechanism will be required to fully determine its merits, both with the centrifugal dirt eliminator and the oil dipped metal type filter.

One railroad, due to the fire hazard involved in using paper media with the Electro-Airmat, attempted to use this filter without the electrostatic charge on either the ionizers or collectors. This was found to be very unsatisfactory due to the paper media plugging rapidly with dirt and lint.

Temperature and Humidity Control

On its assignment to investigate various types of temperature and humidity control, the committee reports as follows:

Considerable trouble has been experienced with "split" mercury columns on cooling thermostats due, apparently, to mechanical shock, electrical surges or heavy currents in the coil circuits of the cooling pilot relay.

The manufacturers of mercury tubes are doing considerable development work in the design, fabrication and testing of these units to eliminate possible failures due to mechanical shocks.

The failures due to electrical surges are the result of the heavy inductive kick of the operating coil of the cooling pilot relay. This can be overcome by placing a high resistance across the gap of the tube contacts or by placing a fixed condenser across the terminals of the relay coil.

Failures due to heavy currents in the coil circuit can be eliminated by employing high resistance relay coils or by placing a high resistance on each side of the tube to limit the current flow so that it does not damage the tube.

Because of the above-mentioned defects, several other types of thermostats have been introduced which do not involve mercury tubes. Two of these are Fulton Sylphon units, one of which employs a liquid-filled tube, the thermal expansion effect of this liquid operating its own snap action control switch and thus eliminating the use of cooling pilot relay. Preliminary tests indicate that this unit is not as sensitive as a mercury tube thermostat and may result in appreciable temperature swings in car temperature.

The other Fulton Sylphon thermostat utilizes a bimetallic thermostatic element to actuate a cooling pilot relay. Tests indicate that this type unit is less sensitive than the liquid-filled unit and will permit a greater change in the car temperature than the mercury tube type thermostat.

The G-V Controls Incorporated has developed a metallic tube type thermostat element, the expansion of which is multiplied through a system of levers to actuate the switch contacts which are hermetically sealed within the above-mentioned metal tube. Preliminary shop tests indicate that this device has merit, but road service will be necessary to establish if it can avoid appreciable temperature swings in the car.

The desirability of the completely automatic panel in room type sleeping cars is questionable, and it is the opinion of the committee that on cars which have an attendant in charge, at all times while occupied, a manually selective type of temperature control switch is more advantageous.

Hermetically-Sealed Refrigeration Units

In response to its assignment to report on hermetically-sealed units for air conditioning and refrigeration purposes, the committee includes a description of such equipment installed on the Talgo train built by the American Car & Foundry Company, and now in service in Spain. This was described in the July 1949 issue of *Railway Mechanical Engineer*. Concerning the performance of the equipment, the report states:

Minneapolis-Honeywell electronic type temperature controls are employed to regulate the ventilating, cooling and heating of the cars.

From the information available, the system is working satisfactorily.

Both heating and cooling apparatus as applied to Rock Island coach 209 have been in service for almost two years, and excellent results have been obtained with the hermetically sealed compressors. The system of heating control employing saturable core reactors has proven very satisfactory.

The remainder of the report outlines recommended practice, respectively, for:

1. Inspection and maintenance of Carrier-Safety steam ejector air conditioning equipment at maintenance terminals.
2. Inspection and maintenance of water-ice air conditioning equipment at maintenance terminals.
3. Inspection and maintenance of electro-mechanical air conditioning equipment at maintenance terminals.
4. Recommended characteristics for a desirable heating system for passenger train cars, and also describes methods which have and are being developed for waste-product heating and individual car heating plants.

On the latter two subjects, the committee reports as follows:

Waste Product Heating

Diesel undercar power plants have definitely provided a new source of heat in the car heating field. General Electric, Frigidaire, and Westinghouse, as builders of these power plants, have shown decided interest in the possibilities of utilizing heat recovered from engine exhaust and engine coolant, for heating passenger train crews.

From figures, furnished by these builders, with the engine operating under approximately a 20 kw. load, an average of 185,000 B.T.U. per hr. is available from a combination of exhaust and radiator system of these engines. These figures take into consideration the efficiency of heat exchangers and loss through piping, etc. During heating season, when air conditioning power for condenser and compressor is not required, the 20 kw. load on engine includes 15 kw. of electric heat, which provides an additional 51,000 B.T.U. per hr. for car heating. These figures indicate that heat available from a Diesel power plant would more than meet the requirements of the car.

These builders, however, are not in the car heating business and in considering waste product heating, their first concern is the necessity for protection of the Diesel engine at all times, by making certain that the engine cooling system is in no way restricted from functioning in a normal manner. They recommend the use of electric heat in noncooling seasons to reduce the percentage of time that the Diesel engine would operate under extremely light loads, which might lead to fouling of injectors and subsequent maintenance. Also possible is excessive smoking which is objectionable around passenger train cars.

To make use of this heat, made available by application of Diesel power plants to passenger train cars, Vapor Heating Corporation, Minneapolis-Honeywell Regulator Co. and Fulton Sylphon Division of Robertshaw-Fulton Controls Co. have developed car heating systems embodying waste heat recovery, use of heat from surplus electrical energy and provision for heat from train line steam in emergency or layover periods when Diesel engine is not in operation. To provide a common means of transferring heat from these sources and releasing it in the required amounts to all sections of the car, a circulating fluid is used in all systems.

The Vapor system uses the standard Cycle Modulation method of controlling car temperature except that solenoid valves are used in place of steam admission valves. The system is designed to provide layover protection of the car without the necessity of operation of the Diesel power plant. The fluid circulates by thermosyphon when heated by standby supply of steam from outside source. Electrical controls are not energized when Diesel engine is stopped, except standby control which must be operative when power plant is not running. Control requirements will not call for a battery of larger size than normally needed.

The circulating system consists of a pump forcing the heated liquid first to an overhead expansion tank, then to the overhead heat radiator, through this radiator and downward in parallel paths through floor heat radiation on both sides of the car and returning to pump. This liquid is heated through automatic control arranged to pick up each of the various sources of heat in the following sequence:

1. Available or surplus electrical power.
2. Heat from coolant system of Diesel.
3. Heat from exhaust gases.
4. From steam.
   (a) to augment the first three methods if they do not provide sufficient capacity
   (b) to provide a complete supply to the car if other means are not available.

When thermostat in car body calls for heat, power is supplied to electric immersion heaters to raise temperature of circulating fluid and create load on Diesel engine. Provision is made to admit engine coolant to the circulating fluid when increased heat is required in car provided that engine temperature is at recommended temperature. A thermostatically controlled damper on exhaust line of Diesel will direct flow of exhaust gases through heat exchanger to further heat circulating fluid if required.

All electrically operated valves are so arranged that their normally deenergized position will provide for thermo-syphon circulation.

The system is provided with an underneath filling device which provides for pressure filling at initial charge. A funnel cock is applied to the expansion tank which will allow replenishing when required.

The Minneapolis-Honeywell system uses the standard Honeywell "Electronic" Moduflow method of controlling car temperatures; the only difference being that the car is heated by the hot water circulating in the Diesel engine cooling system instead of by steam.

In their opinion the problem is to control the car heating equipment, the heat sources (jacket water, exhaust, electric, steam) and the Diesel engine radiator so as to (1) comfortably heat the car and (2) maintain the Diesel engine jacket water at an efficient engine operating temperature. They feel these are actually two independent control problems and should be handled by separate systems.

The Diesel engine jacket water temperature control involves both heating and cooling of that circulated fluid with automatic changeover. The various components of the system are as follows:

Car and Heating Engine Sources	Engine Cooling Sources
*1. Engine	*1. Car heating system
2. Electric	2. Engine raditor
3. Exhaust	
4. Steam	

Items indicated by an asterisk (*) depend on exterior factors and cannot be regulated by the control system. The engine adds heat to the jacket water in proportion to the electrical load on it, and the car heating system removes heat according to its requirements. The remaining heating and cooling sources, when properly controlled, become the basis for the engine water temperature control system. This system senses the water temperature at the engine, and if it tends to rise, operates the radiator valve as needed; or, if it tends to drop, operates the heat sources (electric, exhaust, steam) as required to maintain the desired engine water temperature.

There is a closed circulating system which circulates the Diesel engine jacket water under the car. Diverting fittings will divert part of this water through the Diesel engine radiator when the radiator Moduflow valve is opened. Steam is admitted to the steam heat exchanger by a Moduflow valve which also operates the electric heat and the exhaust gas diverting valve. This is accomplished by means of overtravel and switches, which operate in the first portion of the valve motor travel, while the steam valve is still in the closed position. Control is from a single electronic thermostat in the water entering the Diesel engine. It controls the heating and cooling equipment so as to keep the engine water at the temperature recommended by the manufacturer.

The control sequence is as follows:

Starting with cold engine water:

1. Radiator valve closed, all heat on full.
   a. All steps of electric heat on.
   b. Exhaust heat on full.
   c. Steam valve full open.

As engine water warms up:

1. Steam valve modulates closed.
2. Exhaust heat cuts off.
3. Electric heat drops out in steps.
4. Radiator valve modulates open.

The car temperature is controlled by the temperature of the water circulated in the two floor heat systems and the overhead heat system. Each floor heat has its own circulator (Overhead heat uses circulating pump in radiator cooling fluid loop) and thermostatically controlled Moduflow valve and is connected to the loop through which is circulated the engine cooling fluid. Temperature of the water circulated in each of these three separate circulating systems is determined by the amount of hot water admitted from the Diesel engine cooling system by the Moduflow valves. Diverting fittings are used to supply hot water to overhead or floor heat systems when Moduflow valves open. No check valve or spring loaded relief valves are required.

Standby or layover heat protection is provided by operating the floor heat surfaces as a steam heating surface. Steam is admitted to an inner tube in the floor heat finned surface which directly heats that surface without requiring the operation of a circulator or depending on gravity circulation of hot water. A self operated valve controls the amount of steam admitted to the inner tube and maintains standby temperature in car at all times even in case of electrical failure.

The Fulton Sylphon system uses the standard Fulton Sylphon method of controlling car temperatures with either modulating or off and on control.

The circulating system consists of a pump forcing the heated liquid through a loop to which are connected feed lines to floor heat surfaces and overhead heating coil.

In the off and on type of control, both the overhead heat and floor heat control is obtained by starting and stopping a circulating water pump. Modulating control may be obtained by use of non-electric self operating valves or modulating thermostat valves controlling the flow of hot water into overhead and floor heat surfaces.

No performance data on waste product heating is available at the present time but will be furnished at a later date.

Heating of passenger train cars with other than direct steam radiation

Minneapolis-Honeywell reports they have designed an "On-Car Hot Water System" for heating passenger train cars, using an on-car hot water generator fired by propane gas or Diesel fuel oil.

The water used in this system as a heating medium is contained in a closed system on each car and need not be replaced as in steam heating systems where condensate is dumped and make up water continually added at boiler. Continuous water treatment is not necessary as the same water is used over and over again.

The water heating control, when propane or other low pressure gas is used, is one water thermostat, one gas valve and a safety pilot. When fuel oil is used, control consists of one water thermostat, one burner relay and a stack switch. The temperature of the water used to heat the car is controlled by the water thermostat and moved through the heater by a circulator located ahead of the heater.

The car temperature is controlled by the standard Moduflow system using hot water as a source of heat as previously described in report on waste product heating.

Vapor Heating Corporation reports they are proposing the Vapor Clarkson No. 4915, oil fired, hot water heater for individual car heating power plants. Heater can be used for heat protection, in layover, of all apparatus that is on the car, especially that apparatus in which starting is a problem in cold weather. This heater has a rated capacity of 150,000 B.T.U. per hr.

The report is signed by K. T. Benninger (*chairman*), general electrical supervisor, Chicago & Eastern Illinois; C. R. Bland, special engineer, air conditioning and electrical equipment, Chesapeake & Ohio; J. L. Christen, yard depot, The Pullman Company; H. J. Dawson, traveling electrical supervisor, Illinois Central; G. E. Hauss, electrical supervisor, Baltimore & Ohio; D. C. Houston, electrical engineer, St. Louis-San Francisco; W. J. Madden, general foreman, Pennsylvania; R. W. Tonning, mechanical engineer, Atlantic Coast Line; A. E. Voigt, car lighting and air conditioning engineer, Atchison, Topeka & Santa Fe; and G. T. Wilson, assistant engineer car equipment, New York Central.

Discussion

In presenting the report, K. T. Benninger (C. & E. I.), said the flame arrestor referred to in the section on ventilation has been most satisfactory.

Questions were raised concerning the use of the carbofreezer (carbon-dioxide refrigeration). H. W. Dillon (T. & N. O.) reported that his railroad has such equipment in service and that it has been very satisfactory. D. E. Jones (C. P.) said his road had also used it, but that they had had trouble with stratification, and that it had been necessary to install a fan for circulation. J. R. Bucy (B. & O.) reported having to add ice on hot days to get effective operation. W. A. Woodworth (S. P.) said that trouble with this type of equipment usually derives from packing the box too full. When this is avoided, he said, it works well. He also recommended that arrangement be made to prevent adjustment of the thermostat. A. E. Voigt (A. T. & S. F.) said that the Santa Fe has a large number of carbofreezers in service and has had no trouble with them. He added that if the crew is educated to avoid overloading, no trouble will be experienced. F. M. Nelson (U. P.) reported on the basis of experience that a fan is good only if there is a place for the air to go. He said the carbon dioxide should be vented and not allowed to stay in the box. R. I. Fort (I. C.) reported that public health service organizations are becoming much interested in temperature control, and said that in Illinois Central applications, shelves have been given wider spacing, and space has been allowed at the sides for air circulation.

A question was raised by Mr. Benninger concerning the rec-

ommendation in the report that a 6-watt lamp be used for testing for grounds. W. S. H. Hamilton (N. Y. C.) said that a voltmeter is an excellent means of testing for grounds—that if meter resistance is specified, then reading means something. He considers the lamp to be an inaccurate means of testing. W. G. Switzer (N. Y. C.) suggested the voltmeter resistance should be 100 ohms per volt. To this R. I. Fort (I. C.) agreed, saying that a 100-ohm meter is better than a 1,000-ohm meter. J. R. Bucy (B. & O.) expressed a preference for the voltmeter and suggested that it be recommended. A. L. Kelly (M. P.) said he considers the lamp entirely practicable.

G. T. Wilson (N. Y. C.) said many troubles traceable to grounds will not be shown by a voltmeter and that since the lamp requires a definite amount of current, it is better. Concerning mercury thermostats, he said, that if they are tested with a lamp of predetermined wattage, the test is satisfactory. R. F. Dougherty (U. P.) voiced a preference for a lamp. J. V. Dobbs (A. T. & S. F.) concurred, saying it was most convenient, and that men always carried one. He said he was fortunate in not having any 110-volt equipment, and said a meter should be used on it. On lower voltages, he said, a 6-watt lamp will pick up any fault that will do any harm. W. J. Madden (P. R. R.) expressed approval of the lamp, but cautioned that the flow of the current through the lamp may be sufficient to break the mercury column in thermostats. G. S. Glaiber (N. Y. C.) said he had made tests with artificial grounds and found that any current greater than 85 milliamperes will boil the mercury in thermostats having a thin bore. With the larger bore thermostats, this value of current caused no trouble. At 150 milliamperes, the current caused an *on* and *off* connection, but did no harm. The chairman asked for opinions from manufacturers and Maurice R. Eastin (Minneapolis-Honeywell) said he believed the lamp would injure thin-tube thermostats. I. S. Gardner (Vapor Heating Corporation) said tests had been run to current values above 200 milliamperes without causing trouble, but that if the current is run high enough, the columns will split. T. J. Kenny (Fulton Sylphon Co.), in speaking of tubes with different bores, said he has found that what is gained in bore, is lost in fragility of the tube.

Tacitly, it was agreed that a meter is more accurate technically, but that a lamp is more practicable. Mr. W. S. H. Hamilton recommended that a 6-watt lamp be used, having a voltage rating corresponding to the voltage rating of the system.

The question of having an emergency switch on automatic air conditioning control panels caused much discussion, which resulted in no agreement.

Automotive and Electric Rolling Stock

A joint meeting of the Locomotive Maintenance Officers Association and the Electrical Section, Mechanical Division, A.A.R., was held Wednesday afternoon, September 20, 1950. One Electrical Section report, that on Automotive and Electric Rolling Stock was presented at this meeting. L. S. Billau (B. & O.) conducted that part of the meeting at which the report was presented and discussed.

The first part of the report includes brief descriptions of the most recently built Diesel-electric locomotives, gas-turbine locomotives, and the Pennsylvania's rectifier car and rectifier locomotives. Two of the latter are now under construction. The car and all of these locomotives have been described in the *Railway Mechanical and Electrical Engineer*.

Sub-Committee B on standardization is endeavoring to establish a standard length for traction motor leads, and is experimenting with motor-lead terminals.

Motor Thermal Capacity

Sub-Committee C was assigned the task of developing a load indicator for Diesel-electric locomotives. It has not accomplished this end, but it has produced a clear explanation of motor heating which shows, incidentally, how little margin remains between short-time and continuous rating of traction motors now in service. This section is reproduced here in full.

No specific progress toward the development of a practical loading indicator can be reported, but there is a definite improvement in the capacities of electric propulsion apparatus which tends to reduce the necessity for loading indicators. Since the reason for this may be somewhat obscure, a brief discussion of the loading of electrically driven locomotives may be of interest in this report.

The adoption of electric drive introduces a time-temperature factor which may place a rigid limit on the tonnage which a locomotive may haul over given profile. In other words, excess tonnage may cause the electric propulsion apparatus to overheat and become damaged, which damage is seldom immediately evident from casual inspection. The purpose of the loading indicator is to prevent such overheating. Increases in the electrical capacities of this propulsion apparatus serve to reduce the possibilities of overheating, but if large enough electrical equipment were installed to insure that it could never be overheated, the average locomotive would be burdened with excessive cost, weight, and repair expense.

The passing of electric current through the windings of an electric machine generates heat, this heat increasing approximately as the square of the current value. Thus, if the current is doubled, the heat generated is quadrupled. Heavy tractive force requires high electric current values and consequently high liberation of heat. Since the ventilating system can get rid of only so much of this heat, excess tractive force means a rapid rise in the internal temperature. If the temperatures of the machines are low at the start of an overload, an appreciable time may elapse before dangerous temperatures are reached, but if temperatures are high at start, there may be little margin left. This leads to the establishment of continuous ratings and short time overload ratings. The former is fixed by the current value which may be sustained continuously with the ventilating system carrying off heat at the rate at which it is generated. Short time ratings are established by starting with some established temperature, such as continuous rating temperature, and fixing the time required at each elevated tractive force value to reach a temperature considered dangerous to the equipment.

Any electrically driven locomotive has three well defined limits which affect train operation:

1. Maximum tractive force for train starting.
2. Maximum locomotive speed as limited by safe rotational speeds of traction motor armatures.
3. Safe temperatures of electric apparatus.

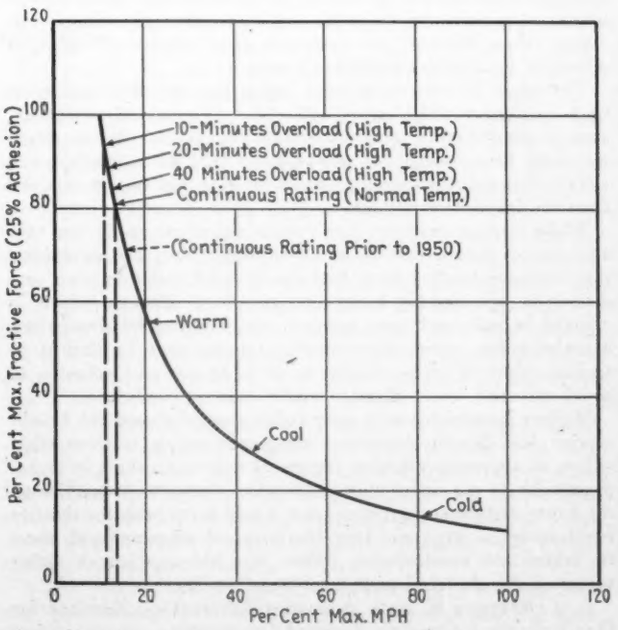


Fig. 1—Diesel-electric locomotive typical characteristic curve showing relative electrical equipment temperatures and small overload margins

Maximum starting tractive force usually depends upon the effective weight on driving wheels and the coefficient of adhesion between these wheels and the rails. There are occasional exceptions to this, especially for high speed locomotives where the starting tractive force may be limited by the maximum current which is permissible through a motor at standstill. Except for these, however, a maximum tractive force equivalent to 25 per cent of the weight of drivers may be considered as normal.

All locomotives have a maximum speed value as limited by mechanical considerations. For a reciprocating steam locomotive, this limit may be fixed by the dynamic unbalance of connecting rods which damages the track. For electric drive, maximum permissible locomotive speeds are usually limited to values well below the rotational bursting speed of the traction motor armatures, the actual values being determined by the designers of the equipment. It is customary to limit such rotational speeds to values within which reasonable electrical maintenance may be obtained. For a given wheel diameter and gear ratio, this maximum motor r.p.m. defines the maximum locomotive m.p.h.

Limits in maximum tractive force and in locomotive speeds are important, of course, but provisions to insure operation within such limits are easily installed. However, the most important limitation in the operation of electrically driven motive power from the standpoint of expense to the railroad and locomotive reliability is that of tonnage loadings, which limitation was of secondary importance in the operation of steam power and merely caused inconvenience rather than damage. This sub-committee's assignment arises from the fact that tonnage loadings are of prime importance in the operation of electrically driven locomotives, that there is no specific method by which the average operating man can determine how far he may load such motive power, and there exists no reliable device or circuits for immediately indicating the effect of overloading. At present, the most dependable method of preventing excess temperatures of electrical apparatus is to adhere rigidly to the ratings established by the locomotive builders or by the motive power department. It must also be fully understood that with a given locomotive and electrical equipment, the tonnage rating depends solely upon that equipment and not upon the applied horsepower. For instance, if a 1600-hp. Diesel engine were lifted out of a locomotive and replaced by a 2000-hp. prime mover, the effective tonnage rating of the unit would not be increased—the train would merely move faster with the same trailing tonnage.

The graph, Fig. 1, shows the speed-tractive force characteristic of a Diesel-electric locomotive, expressed in per cent of maximum safe speed (as limited by traction motor armature r.p.m.) and of maximum tractive force (at 25 per cent adhesion). Short time rating values illustrate the extremely short periods of operation allowable for high tractive force values.

The range between continuous rating tractive effort and short time overload ratings varies with different types of equipment, sizes of motors and generators, cooling system, etc. Actual values for short time ratings for any specific type of locomotive and electrical equipment should be based on data that can be obtained from the locomotive builders.

While starting tractive effort values equivalent to 25 per cent adhesion or higher can be obtained under favorable conditions, the maximum tractive force that can be used under running conditions is considerably lower due to wheel slippage, which is affected by rail conditions, weather, etc. For freight locomotives, experience has shown that tonnage ratings must be limited to tractive effort values equivalent to 18 to 20 per cent adhesion to avoid excessive wheel slippage under running conditions.

Modern locomotives with gear ratios generally used for freight service will develop maximum continuous rating tractive effort values at appreciably higher factors of adhesion, which it is impracticable to use under most conditions. Under these conditions, the motor and generator ratings that would occur with the tractive effort values as determined by the factor of adhesion used, must be taken into consideration rather than the continuous rating values of the electrical equipment based on heating.

It is customary in some locomotive builders' specifications for Diesel electric locomotives designed for switching service, to furnish maximum starting tractive effort values only, as due to the intermittent and variable loading characteristics for this class of service continuous rating values are of little use. However, there is a tendency on most railroads for an increasing use of Diesel electric switching locomotives in miscellaneous helper, transfer, and local freight operations in which the tonnages that can be handled will be determined by the continuous rating values of the electrical equipment.

It is therefore recommended that specifications for this class of locomotive should include maximum continuous rating tractive effort values and corresponding ampere values.

Wheel-Slip Protection Devices

Sub-Committee D, assigned to investigate wheel-slip protective devices reports as follows:

A questionnaire was sent to fifty railroads to determine if the wheel slip arrangement on our present Diesel-electric locomotives and on new locomotives being built was satisfactory to give proper protection against wheel slip and wheel slide. It was to determine what a device of this kind should accomplish in indicating this condition and what action should automatically take place on the operation of the locomotive when such a condition develops. This report is to give the specifications on what a device of this character should accomplish based on the requirements of the majority of the railroads of this country.

The questionnaires which were filled out and returned showed that the present wheel slip and wheel slide arrangement now on the Diesel-electric locomotives and new locomotives being built for freight, passenger and transfer service will not give adequate protection against these conditions. The railroads are not satisfied with this arrangement and feel that the present wheel slip devices should be superseded by a detector system which will give positive indication and protection against (1) wheel slip during acceleration and high speed, (2) wheel slide protection during air and dynamic braking, (3) locked wheel protection and (4) if practicable, to prevent false forward transitions due to wheel slip.

The Diesel-electric locomotive requires protection against wheel slip and wheel slide that was never felt generally necessary on other types of locomotives as wheel slips are received at low speeds as well as speeds in excess of 60 miles per hour and wheel slide can occur at any speed. A positive wheel slip and wheel slide detector system is badly needed to prevent excessive traction motor and locomotive speed, to allow the engineer to detect any wheel slip on any pair of wheels under all coupled locomotive units, to prevent damage due to locked wheels, to prevent wheel slide during air and dynamic braking and to prevent false forward transitions.

Most of the Diesel-electric locomotives are equipped with a wheel slip arrangement for detecting locomotive wheel slip by the detection of electrical unbalance between traction motors. This device is wired through the isolation switch and can be isolated to prevent its operation. In case of locked armature bearings, the main generator will flash over causing the ground relay to operate and the traction motors are electrically disconnected from the generator which renders the wheel slip protective feature.

In mountain operation, it has been noted that all the power wheels under a unit will slip simultaneously and this condition is not detected as there is no electrical unbalance between the traction motors. Wheel slip on Diesel-electric locomotives has caused the locomotive overspeed device to operate as well as false forward transitions on locomotives which make transition on speed.

The problem of wheel-slip and locked-axle protection has been given considerable study by the railroads and locomotive builders to determine the requirements for a complete scheme of protection which could be made standard for all classes of Diesel-electric locomotives in use at the present time. Due to the different types of Diesel-electric locomotives in service today this positive protection can be accomplished only by the application of axle mounted equipment and this can be made standard on all types of locomotives used in all classes of service.

The specifications of a positive wheel slip and wheel slide protection device should consist of the following:

1. Axle mounted equipment.
2. Relay panel.
3. Alarm system.

The axle mounted equipment can consist of either: (1) axle

mounted commutator and brush system; (2) individual axle generators; (3) axle mounted centrifugal switches mounted on each power and idler axle under each unit and to operate on a 5 mile per hour speed differential between each axle regardless of the speed at which the locomotive is being operated.

The relay panel should consist of relays of the proper type that will operate with the axle equipment when the 5 miles per hour speed differential is reached between any axles under the unit. The relay system is to be connected to the main generator excitation system so that in case of wheel slip, the excitation of the main generator and the engine speed will reduce, unloading the Diesel engine until wheel slippage stops and the engine will again slowly resume full load and speed. The relay panel should also have a timing device with a manual reset, which will operate when slippage continues for approximately thirty (30) seconds indicating an abnormal condition such as a locked wheel. This control circuit should be independent of other equipment and functions even though the unit is cut out.

This device should operate the wheel slip light and buzzer on wheel slippage in the operating cab, and, in addition, when the timing relay operates it should operate the alarm signal system and light an alarm light on the relay panel on the unit causing the alarm. This timing device should be capable of being reset only on the unit affected, and should be reset only after making an inspection of the unit. This timing device should operate the alarm circuit through a separate unfused circuit in a separate conduit from the battery.

This protection device could also have the overspeed protection incorporated into it which would eliminate the overspeed protection now on the locomotive. It is felt that we would have better operation with less maintenance if as many devices are eliminated from the locomotive as possible.

On our present wheel slip protection the only practical control is by requiring action by the engineer, he can only correct slipping on any one unit by reducing the power on all units. The resultant loss of tractive effort is undesirable. By having the wheel slip protection connected so the electrical load on the Diesel engine is partially reduced will require no action by the engineer and no great loss in tractive effort of the locomotive will be noted and the light and buzzer will give the engineer warning that wheel slippage is being experienced. It might be necessary to reduce the throttle under very abnormal conditions. Locked-axle protection definitely requires a cab indication and action on the part of the engine crew and it will be necessary that instructions be given them on what to do in case the alarm system stays on.

The specifications for the wheel slip and wheel slide protection were set up with a view of simplifying and eliminating as much equipment as possible on the locomotive and to give positive protection that could be made standard on all types of Diesel-electric locomotives in all classes of service. These specifications will be coordinated with the work being handled by the Diesel locomotive section of the Locomotive Construction Committee of the Mechanical Division of the Association of American Railroads.

Sub-Committee E on standard symbols presents tables showing designations and identification letters for Diesel locomotive parts.

Progress in the application of sealed-beam lamps is reported by Sub-Committee F.

Control of Battery Voltage

The past work of the Sub-Committee G on battery voltage control has been a study of methods and devices for automatically controlling the destructive overcharging of storage batteries in diesel electric locomotive service, occurring when the batteries become overheated due to internal or external causes. As the battery temperature rises, the charging current automatically increases for the same voltage setting of the charging circuit, with the consequence that the factors that increase the temperatures of the batteries are cumulative in their effect.

Some experiments have been made of regulating the charging current through temperature relays controlled by the temperature of the battery itself. While these tests were successful, control devices of this character have not been commercially developed. However, due to better ventilation of battery compartments and improvements in control equipment in general use, the need for the greater refinement in temperature control for protection against overheating batteries appears to be disappearing.

With the greater use of Diesel electric locomotives, particularly switching locomotives at outlying points where they are not housed during layover periods, the need is developing for improvements in the control in the charging of batteries where they are exposed to cold weather conditions. Where locomotives may be operated under conditions where the battery temperature might fall to 40 deg. F. or lower, not only is there a temporary reduction in the ampere hour capacity of the battery, but also reduction in charging rates for the same voltage setting of the charging circuit with the result that batteries may become undercharged to the extent they are unable to start the engines.

Tests of temperature control devices actuated by battery temperature conditions which will increase the charging rates under these low temperature conditions are underway. It is expected that by another year sufficient experience will be obtained with the use of devices of this character to indicate whether or not they will justify commercial development.

Locomotive Controls

The work of the sub-committees this year has been confined to study of alarm signals, lights and bells, including their functions, design of signals, and location.

Replies received from a questionnaire sent to the chief mechanical officers of twenty-eight railroads, indicate a majority preference that:

(a) All safety device alarms (low lube oil pressure, hot engine, steam generator failure, etc.) give a visual signal at corresponding engine or steam generator control panel.

(b) The engineer only need be visually signalled for power-off switch operated and dynamic brake limit.

It is now the intention to outline a proposed standard arrangement which would be sent to the chief mechanical officers for their approval or criticism.

The report is signed by L. S. Billau (*chairman*), electrical engineer, Baltimore & Ohio; E. J. Feasey, superintendent of Diesel equipment, Canadian National; J. C. Foster, electrical foreman, Atlantic Coast Line; W. S. H. Hamilton, engineer, electrical equipment, New York Central; H. C. Paige, assistant mechanical engineer, New York, New Haven & Hartford; J. Stair, Jr., electrical engineer, Pennsylvania; C. F. Steinbrink, general electrical foreman, Chicago, Rock Island & Pacific; H. C. Taylor, Diesel superintendent, Southern; C. A. Wilson, assistant supervisor, Diesel engines, Atchison, Topeka & Santa Fe; and P. H. Verd, superintendent motive power, Elgin, Joliet and Eastern.

Discussion

The report was presented by L. S. Billau (B. & O.) and the several sub-committee chairmen.

Several members emphasized the importance of allowing sufficient time following a wheel-slip and power cut-off before power is reapplied, and it was suggested that an interval of five seconds be allowed to elapse after excitation is reapplied, before the engine is allowed to go back to speed.

H. M. Harrington (Alco-G. E.) expressed the belief that the manufacturers can supply all the needed protection, and that in current Alco-G. E. equipment, it had been accomplished. Excitation, he said, is not removed entirely, and when the slip has been arrested, the engine load is reapplied in a slow gradual curve. It has, he said, been thoroughly tested, found effective in slow-speed slip, and will be made equally effective in high-speed slip.

G. W. Brownell (Electro-Motive Div., General Motors Corp.) said the interest of his company had been stimulated by New York Central studies of high-speed slip. He said that Electro-Motive had developed a wheel-slip circuit which will reduce power just enough to stop slip, and then reapply power at a rate which will not cause a second wheel slip. This, he said, will be incorporated in locomotives.

W. W. Wagner (Westinghouse Air Brake Co.) said his company had recognized the seriousness of wheel slip, and that since they do not have transition, they are not troubled by slip at transition. The rate at which load is restored is governed to suit the various engines with which Westinghouse Air Brake equipment is used.

Air Brake Association Holds Forty-second Annual Meeting

Members hear papers on maintenance, elimination of moisture, ABLC tests, charging long freight trains, and air flow characteristics

C. E. Miller
President
(Superintendent air brakes and steam heat, N. Y. C. System)

THE fourth annual meeting of the Air Brake Association as a member of the Coordinated Railroad Mechanical Associations, and the 42nd annual meeting of the association itself, was held at the Hotel Sherman, Chicago, September 18 through 20. The meeting was opened with a brief welcoming address by President Miller who defined the purpose of the association as one to establish standards of procedure for maintaining car and locomotive brake equipment and to see that such standards are maintained. He noted that the establishment of such standards and their maintenance has been and will continue to be the result of close cooperation between railroad management, railroad maintenance forces and manufacturers' representatives.

The opening session on Monday morning was devoted to a report of a committee on approved maintenance practices. The first day's afternoon session heard reports on broken pipes of Diesel locomotive air brake equipment and the elimination of moisture from Diesel locomotive air compressor cooling system.

On Tuesday morning reports were presented on brake pipe leakage, charging long freight trains and the facilities required, and test results and design changes in load compensating brake equipment.

The final day was opened by a paper on the maintenance of Budd disc brakes. This was followed by a paper on how good brake system maintenance improves freight train handling and one on the characteristics of air flow in automatic train braking. The final paper was on troubles and remedies of 24 RL brake equipment.

Election of Officers

The following officers and board members were elected to serve for the coming year:

President, F. C. Wenk, general mechanical instructor, Atlantic Coast Line; First Vice-President, K. E. Carey, assistant road foreman of engines, Long Island; Second Vice-President, R. F. Thomas, general air brake inspector, Canadian Pacific; Third Vice-President, C. V. Miller, general supervisor of air brakes, New York, Chicago & St. Louis; Secretary-Treasurer, L. Wilcox.

Two new members of the executive committee were nominated from the floor: L. A. Stanton, general air brake instructor, Great Northern and C. E. Bergman, supervisor of air brakes and train control, Union Pacific. The following three members of the executive committee continued in office: D. R. Collins, superintendent air brakes, Denver & Rio Grande Western; R. J. Dewsbury, general air brake inspector, Chesapeake District, Chesapeake & Ohio; C. C. Maynard, chief inspector of air brakes, Canadian National.

Characteristics of Air Flow in Automatic Train Braking

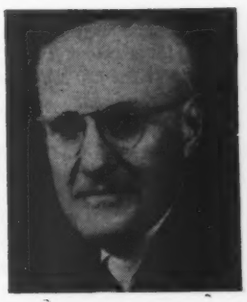
One of the most important devices in an automatic air brake system is a series of lengths of 1¼ in. pipe connected by hoses and couplings known as the brake pipe. Although a multitude of variations makes it impossible to apply any exact mathematical formula to the flow of air through the brake pipe, it is in a very definite sense an orifice. In fact, in many brake functions, especially in train charging, it is the controlling orifice. The amount of air flow through an orifice is in a general way directly proportional to its cross section area and the pressure of entering air, the head pressure, and inversely proportional to the length of the orifice and the pressure of air at the downstream end, the back pressure.

The flow capacity through the brake pipe is affected by the four factors mentioned above as with any other orifice. The cross section area of the inside of a 1¼-in. extra heavy pipe is about 1.28 sq. in. Although the smallest area in the passage ways through the hose and coupling assemblies is somewhat less, in an ordinary orifice of short length, this area would be ample to permit a large flow of air. However, the other factors

F. C. Wenk
First Vice-Pres.
(General mechanical instructor, A. C. L.)

C. V. Miller
Second Vice-Pres.
(General supervisor air brakes, N. Y. C. & St. L.)

L. A. Stanton
Third Vice-Pres.
(General air-brake instructor, Grt. Nor.)



L. Sillcox
Sec.-Treas.

are not so favorable. The head pressure is limited to that of feed valve setting. The orifice length which tends to reduce capacity is an imposing factor. Brake pipe lengths vary but on freight cars, for example, a minimum average would be 45 ft. Hence, on an average freight train of 150 cars, all the air needed on the rear half of the train has to pass through more than 3,300 ft. of brake pipe before it reaches the 76th car. This same 3,300 ft. length of pipe must also supply air to the 75 cars throughout its length.

The effect of brake pipe length on capacity is illustrated on Fig. 1, which shows the results of a series of tests run by opening the angle cock at the rear of freight trains of various lengths and measuring the air flow in cubic feet of free air per minute delivered to the brake valve by the main reservoir system. The feed valve was set at 70 lb. and brake pipe leakage fixed at a minimum. There were no emergency vent valves open at the time of readings. You can see that while a brake pipe length of 20 cars had a capacity under these conditions of approximately 140 cu. ft. per min., a length of 150 cars had only 62 cu. ft. per min., or less than half. Lengths of less than 20 cars would have shown a great increase in capacity had the facilities available been sufficient to measure the flow. This is evident from the shape of the curve immediately beyond 20 car lengths.

The orifice back pressure varies, of course, with the state of charge of the train and approaches the head pressure as charging progresses. Hence, flow through the brake pipe is relatively great when a charge is beginning and slow during the latter and longer period of charging.

Brake pipe leakage, also, has a marked effect on air flow in the brake pipe since it increases materially the amount of air flow demanded by the brake system. For example, on a 150-car freight train with 7 lb. per min. leakage uniformly distributed throughout the train length, about 52 cu. ft. of free air per minute is required just to maintain leakage when the system is charged to its maximum. This is not much less than the flow through a wide open angle cock at the rear of the same train.

Freight Train Charging

Freight train charging is of particular importance since it requires time often when time is a critical item from a railroad operating standpoint. The scope of this paper is limited to trains and, therefore, no consideration is given to yard charging and other effective means for expediting preparation of cars for movement in trains.

It has been mentioned that the brake pipe is the controlling orifice in train charging. Test results prove this beyond a doubt. There are only two other possible restrictions between air supply on the locomotive and the car reservoirs. The first is the locomotive air brake equipment. We shall assume, for the time being, that the supply of air is adequate, that is, that it is sufficient to maintain main reservoir pressure at a few pounds above feed valve setting.

On the locomotive the entire air supply for charging flows from the main reservoirs through the feed valve and the automatic brake valve into the brake pipe. The best that can be done is to bring the locomotive brake pipe pressure up to feed valve setting in the shortest possible time and hold it there throughout the charging period. On a 150-car freight train with a feed valve setting of 70 lb., a train with a uniformly distributed brake pipe leakage of 4 lb. per min. and 8-ET locomotive brake equipment with type F feed valve, the locomotive brake pipe pressure rose to 69 lb. in less than one half minute and reached 70 lb. in about 2 minutes after charging was started. If it were possible to bring the locomotive brake pipe pressure up to 70 lb. instantly, the most time that could be gained in charging the train would be somewhat less than one-half minute.

The second other restriction is the charging ports or feed grooves of the AB control valve. The auxiliary and emergency reservoirs on the first car build up in pressure much slower than the locomotive brake pipe. On car 150, however, the brake pipe pressure does not exceed that of either reservoir by more than 3 or 4 lb. at any time, and after they are charged to 40 lb. the difference is even less. In fact, during the latter part of the charge the difference is no more than that required to maintain a flow. Even on a 75 car train there is little difference between reservoir pressure and brake pipe pressure during the later part of charging on the last car.

We can conclude that the brake system on a freight train of any appreciable length is capable of absorbing air to the maximum obtainable charge as fast as the brake pipe is capable of delivering it. By process of elimination, therefore, we must conclude that in train charging the brake pipe is the controlling orifice and that with modern equipment we have practically reached its present capacity.

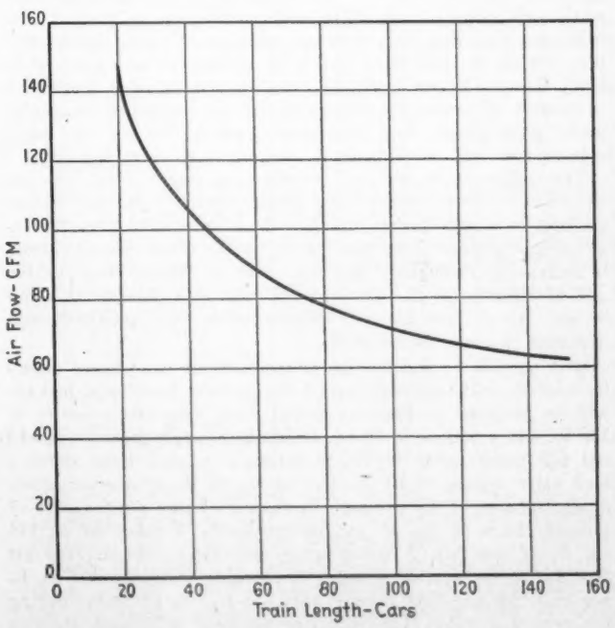


Fig. 1—Air flow in cubic feet of free air per minute through an open brake-pipe angle cock at the rear of various length trains with 70-lb. brake-pipe pressure and minimum brake-pipe leakage

Inasmuch as charging time is a critical item in freight operation let us take a look at some test results involving charging time and factors which affect it. Fig. 2 shows rear car auxiliary reservoir pressure plotted against time during charging to 70 lb. on trains of 75, 100, 125, and 150 car lengths with uniformly distributed brake pipe leakage of 4 lb. and 7 lb. Train length is, of course, the principal factor in charging time but note the effect of brake pipe leakage on both time and the ultimate obtainable pressure on the different train lengths. On a 150 car train the difference between 4 and 7 lb. leakage means a loss of 10 minutes in charging time up to 55 lb. rear end pressure and about 20 minutes up to 57 lb. which is very near ultimate pressure obtainable at rear of a 150 car train with 7 lb. leakage.

The tests mentioned were all run on a test rack built to simulate as nearly as possible conditions prevailing on actual trains. Sufficient comparisons, especially in charging times, were made between test rack results and results of tests run on actual trains to give adequate assurance that those obtained on the rack have a real significance and can be used to predict with surprising accuracy what will occur in service.

Fig. 3 shows a comparison of auxiliary reservoir charging on the rear car of a 150-car train charged to 70, 80 and 90 lb. brake pipe pressures. The brake pipe leakage on this train was measured at 6 lb. with a 70 lb. brake pipe. There is little difference in charging time under these three pressures. At the end of 60 minutes the 70, 80 and 90 lb. charges are respectively 12, 13 and 15 lb. under feed valve setting and at the end of 70 minutes they are all within 2 lb. of their ultimate pressures. Comparing these charges in another way, at the end of 60 min. they are all within a few tenths of a per cent of 83 per cent of feed valve setting and 95 per cent of their maximum. It is safe to say that at ultimate pressure the main part of the difference in sag or taper below feed valve setting is due to greater leakage flow at the higher pressures.

All the preceding data has been taken from tests run with main reservoir pressure maintained at 130 lb. With variations in main reservoir pressure, so long as the pressure does not fall below a point sufficiently above feed valve setting to assure proper operation of the feed valve, the effect is not marked. Charging is not retarded to a great degree on a 150-car train charging to a 90-lb. brake pipe pressure whether the main reservoir pressure is maintained at 130 or 100 lb.

There has been much misunderstanding regarding the relationship between locomotive compressors and main reservoir capacity and charging time on freight trains. All that the locomotive air supply and brake system can do to produce the minimum charging time for any train is to bring brake pipe pressure up to feed valve setting as quickly as possible and to hold it there. It can easily be determined whether a locomotive is capable of producing this result by observing the locomotive brake pipe gauge. Any additional capacity beyond this basic requirement will have little if any effect on charging time.

The difference in air flow for charging trains of 50, 100 and 150 cars to 70 lb. brake pipe pressure with 6 lb. per minute leakage is slight during the first 5 minutes but becomes increasingly greater from that point on as brake pipe pressure is increasing throughout the train. On a 150-car train at the end of 20 minutes the air required with 6-lb. leakage is about 80 cu. ft. of free air per minute while that required with minimum leakage is about 65.

It is possible to make rough calculations on compressor capacity needed. A 150-car train with 6 lb. per min. brake pipe leakage will be assumed to have an initial main reservoir pressure of 130 lb. and a volume of 58 cu. ft. Main reservoir pressure should not fall much below 85 lb. to maintain a good head above a feed valve setting of 70 lb. This leaves 45 lb. or approximately 3 atmospheres of air pressure in reserve. Three atmospheres of pressure in a 58 cu. ft. volume represents 3 times 58 or 174 cu. ft. of free air. A conservative estimate of the average air flow during the first 10 minutes of charging would be 200 cu. ft. per min. for the first minute and 135 cu. ft. per min. during the next 9 minutes. Then the free air used is 200 cu. ft. plus 9 times 135, or 1215 cu. ft. for a total of 1415 cu. ft. Subtracting the 174 cu. ft. of reserve there is left 1241 cu. ft. that the compressor must furnish during the first 10 minute period, requiring a capacity of 125 cu. ft. per min.

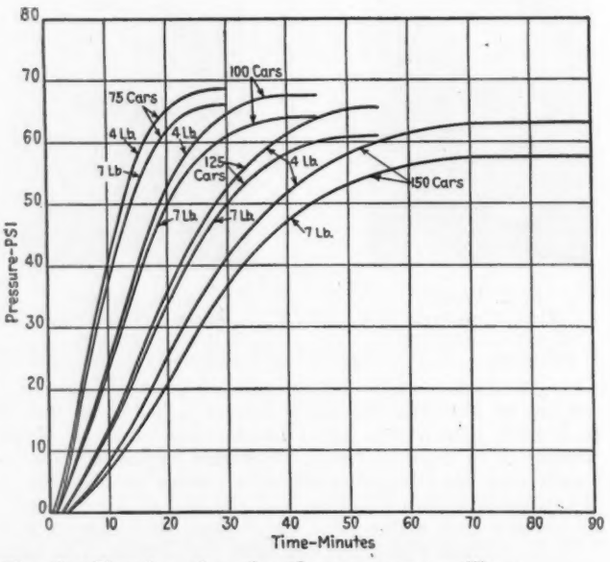


Fig. 2—Charging time for the rear car auxiliary reservoir on various length trains with 4 and 7 lb. leakage unifomly distributed—The main reservoir pressure is 130 lb. and the brake pipe pressure 70 lb.

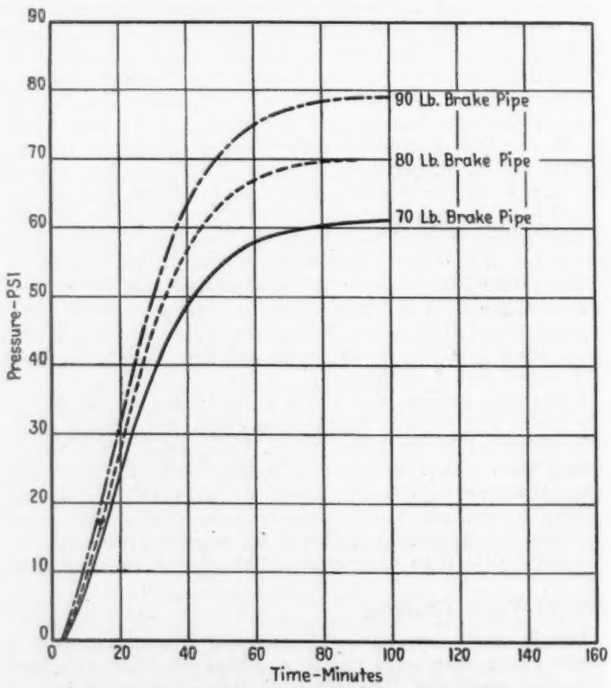


Fig. 3—Rear car auxiliary reservoir charging time on a 150-car train with three different brake-pipe pressures—In each case the leakage is 6 lb. per min. uniformly distributed, the brake-pipe pressure 70 lb., and the main-reservoir pressure 130 lb.

When a freight train is completely charged the pressures in the brake pipe at various points throughout its length come to rest at values depending for the most part on the condition of brake pipe leakage. Brake pipe pressure on the locomotive, of course, is always at feed valve setting. The most important variation is that of the brake pipe at the rear. Fig. 4 shows rear car brake pipe pressure under fully charged conditions with a 70 lb. feed valve setting on various length trains and with various uniformly distributed leakages. These pressures are the ultimate obtainable under the conditions indicated. Their difference from feed valve setting is referred to as train line taper.

While uniformly distributed leakage is probably the average

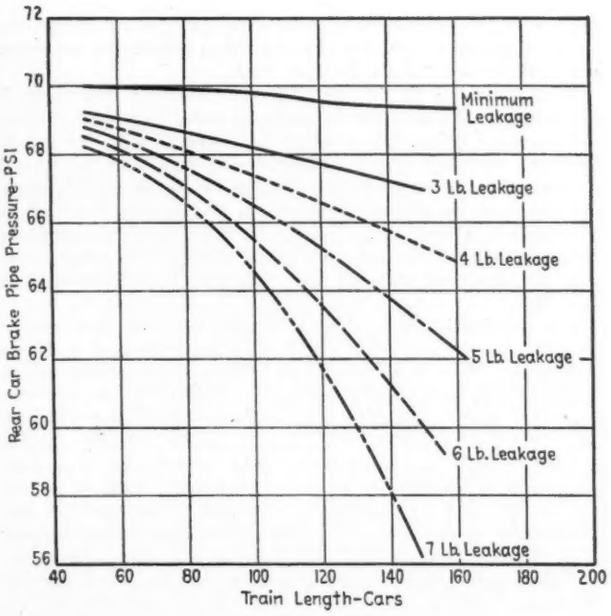


Fig. 4—Maximum rear car brake pipe pressure on trains of various lengths and leakages with 70-lb. brake pipe pressure and uniformly distributed leakage

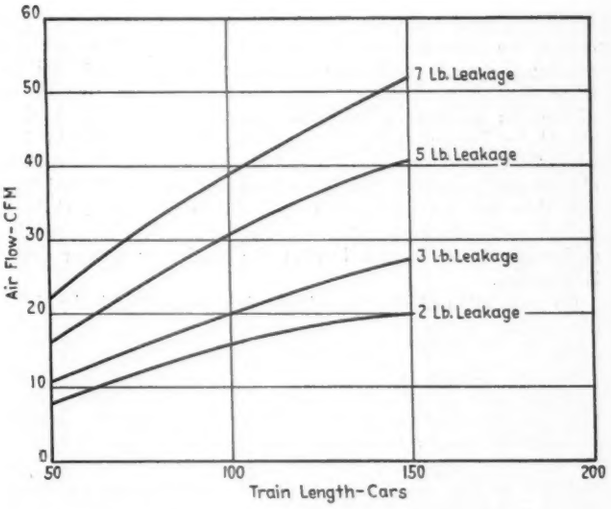


Fig. 5—The cubic feet of free air per minute required to supply various brake-pipe leakages on various cars with 70-lb. brake-pipe pressure

condition found in service, a concentration of leakage from the brake pipe in one or another section of the train can produce entirely different conditions. With leakage concentrated at the head end the train taper is relatively small. With leakage concentrated in the middle, the taper is comparable with that on a train with the same leakage uniformly distributed. With leakage concentrated in the rear the taper is increased considerably over average conditions. On trains longer than 100 cars a concentration of leakage at the rear would increase taper to an entirely intolerable degree. This difference in taper is due to the difference in brake pipe length through which air must flow to maintain the loss due to leakage. In fact, train line taper, although it is usually constant when a train is fully charged, does not represent a static condition but rather a condition of balanced flow wherein the air supplied is just equal to that being lost due to leakage.

Fig. 5 shows the amount of air that must be supplied to the brake pipe just to maintain leakage on trains of from 50 to 150 cars with various leakages. Feed valve setting is 70 lb. and leakage uniformly distributed.

Proposals have been made from time to time for using air on caboose cars for various auxiliary purposes, particularly for driving generators for lighting, radio equipment, etc. Regardless of the system proposed this air must come from the brake pipe and would have the same effect as a concentration of leakage at the rear of a train. Tests have been made to determine the effect on brake pipe leakage of various orifice openings at the rear of various length trains.

Take for example a train of 100 cars with a normal distributed leakage at a minimum (about ½ lb. per min.). A $\frac{5}{32}$-in. orifice open at the rear produces a leakage equivalent to almost 7 lb., which would produce a 10-lb. train line taper. Add this to the taper produced by a normal leakage of as low as 3 lb. per min. and it becomes completely intolerable. It is not difficult to visualize what conditions would be produced on longer trains.

The foregoing effects would be produced by an air driven auxiliary in the caboose if the air consumption could be kept constant. This would probably never be the case. What, then, would be the effect of an intermittent drawing of air from the rear end brake pipe? As you know, the AB control valve is of necessity very sensitive in its quick service functions to reductions of brake pipe pressure. It has been found by tests that the sudden opening of a No. 30 drill vent on the rear brake pipe of a train of 100 cars or more fully charged with a minimum leakage will produce a service application on all but a very few head end cars. On similar trains with leakage of 7 lb. per min., the same effect is produced with a vent as small as a No. 42 drill. Even if an undesired brake application could be tolerated, this type of application, if detected, can be released only by making a normal and fairly heavy application and release from the locomotive. Stuck brakes would, therefore, be expected.

The report was prepared by W. Frederick Klein, project engineer, New York Air Brake Co.

Discussion

H. I. Tramblie, air brake engineer, C. B. & Q., said that there is a distinct need for a device to tell if there is a flow of air into the brake pipe and if the train is charging. By actual test he found that an angle cock can be opened 20 cars behind the locomotive and the engineman will know nothing about it unless the brakes go to emergency.

Brake System Leakage on Freight Trains

During the past three years the A.A.R. has issued three Circular Letters to member railroads and private car owners concerning excessive brake system leakage on freight trains generally caused by hose coupling and AB valve gasket leakage where sub-zero weather is encountered.

Probably one of the most important items in reducing brake system leakage on freight cars is compliance in detail with Rules 101 and 102 of the A.A.R. Maintenance of Air Brake and Air Signal Equipment on Cars on Shop or Repair Tracks. Proper attention has not been given to many cars in accordance with the above mentioned rules for the last few years. The operating procedure that should be followed to maintain a tolerably tight brake system is given below.

After the single car testing device has been attached to the car and while the car is being charged, the person conducting the test should inspect all flange fittings for loose or missing cap screws and nuts. He should check devices such as the AB valve, the combined auxiliary and emergency reservoir, and the AB brake cylinder to make sure that all nuts are tight and that no bolts or nuts are missing, and that all mounting brack-

ets are in good condition. He should check to see that all pipe clamps are tight and not missing and that the U-bolts for supporting the angle cocks are tight and in place and that the angle cock is at a 30-deg. angle as indicated by the top flat of the hex being in a horizontal position. Angle cock handles should be known to be in operating condition and to lock properly in both open and closed positions and all hose, hose clamps and couplings should be inspected so that it is known that they are not damaged (See Rule 56 in A.A.R. Code of Rules) and gaskets are not worn or defective. The hose coupling gasket should be inspected when the single car testing device is attached.

On completion of the above inspection, proceed with the single car testing of the car in accordance with A.A.R. Instruction Pamphlet No. 5039-4, Supplement 1, dated January, 1950, and where the leakage is found to be 2 lb. or less in accordance with the code requirements, proceed with the remaining tests. The completing of the testing of this car should also include a check for proper brake operation from the opposite end of the car. The purpose of this is to assure that the hose are not defective or that there is no abnormal restriction in the brake pipe in either direction of flow.

Where leakage exceeds the maximum permitted, the pipe bracket, service and emergency portions, all pipe and pipe fittings should be soaped (weather permitting) with the equipment in charging position to determine where this leakage exists.

Where leakage is noted between the portions and the pipe bracket faces, the stud nuts should be tightened. Where leakage is noted at the flange face of the fitting, this should be corrected by tightening the flange fitting cap screws. Where the leakage is at the Wabcotite nut, check for a cracked or broken pipe, and where pipe is broken and where facilities are available for ready removal of the pipe, this should be done. However, where the facilities are not available for changing out the pipe, then the Wabcotite nut and ring should be removed and a Wabcogrip or Flexigrip fitting with its compression ring should be applied. Care should be taken to see that the broken pipe is up firmly against the flange fitting to prevent the possibility of the Wabcogrip compression ring being compressed into the pipe passage. Some cases have been noted where leakage from cracked or broken pipes at flange fittings cannot be readily detected through sound or by soaping. However, by deflecting or vibrating the pipes, the leakage is readily detected, though close inspection should be made at all Wabcotite fittings to permit detecting such cases.

Where leakage is noted at the valve covers, the holding bolts or studs should be tightened, and where leakage cannot be corrected in this manner, the defective portion should be removed in accordance with Rule 111 (page 248, Note 1) of the A.A.R. Code of Rules. Before and during the removal of the portions, proceed in accordance with A.A.R. Instruction Leaflet 2391, Supplement 1 dated January, 1950, covering the proper procedure for carrying out this work, in order to make sure that dirt and foreign material does not get into the portions or into the pipe bracket and strainer.

Another possible source of leakage is at the angle cocks themselves, and where leakage is noted there, and thought to be a measurable source of the leakage on the car, they should be replaced. On completion of the above corrective measures, proceed with the completion of the single car testing of this car in order to make sure that the leakage is within the maximum specified by the A.A.R. Code of Tests.

When cars are in for the three-year Periodic Inspection, it is important that a check be made to make sure that all temporary flange fittings are removed and replaced with the A.A.R. approved standard fittings. This is also important as it will reduce excessive brake system leakage before the car is again due for periodic attention. Important, too, is the fact that it emphasizes the need for applying only those forms of temporary flange fittings which can be readily detected as being other than the approved standard and thus permit their removal at that time.

The question is often raised as to just how this work can be properly carried out with the present facilities and available man power. There is no doubt that a job completely done, which incidentally is prescribed by A.A.R. and I.C.C. Rules, will cost more than where just those corrections are made that must be done in order to get the car back in service. However, where a broad overall cost analysis is made on troubles, etc., from the results of holding up of trains in service; from delays as a result of need for breaking up of such trains, etc., all due to excessive brake system leakage in revenue service because of not having properly corrected same at the proper time, this will show that a job completely done in the yard will pay big dividends.

The members of the committee were W. B. Weightman (Chairman), general air brake inspector, Pennsylvania; J. P. Lantelme, general foreman, Pennsylvania; F. I. Miller, air brake inspector, Pennsylvania; J. H. Steffie, air brake inspector, Pennsylvania.

Discussion

W. E. Vergan, superintendent air equipment and Diesel operation, M-K-T, said if the work is done properly in the shop and on the repair tracks it will not have to be done in the yards.

Another member asked what should be done about broken pipes on the rip track, adding that most roads merely cut a half inch off the end and reconnect because the pipe has no union. The answer was to use Wabcogrip or Flexigrip as temporary repairs. The pipe is pushed down and one of these screwed on. Removal of the temporary repair must be made when the car comes in for brake inspection.

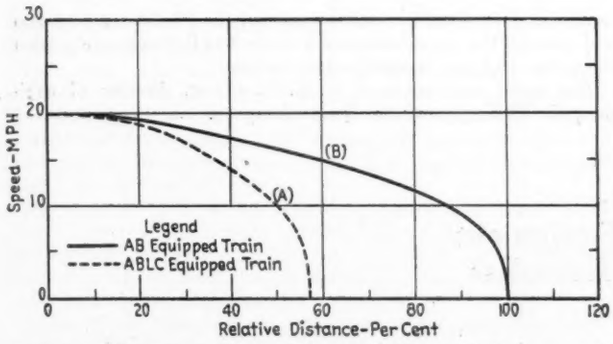
S. R. Ellis, air brake inspector, Reading, said that many cars can pass the terminal test in the yard and still give trouble on the road. A better practice is to use what is known as a system leakage device which finds all the defects. Using it on a division where four 130 car trains per day were dispatched, the first year there were only two failures, the second year, four failures. He would like to see the members get acquainted with the system leakage device as it will find defects before troubles occur on the road.

W. E. Myers, air brake inspector, L. & N., said that it requires heavy center sills, big angle irons and thousands of rivets to hold a car body together. How could the air brake system be expected to hold together when one part is put on the body, a second on the center sill, and another on the frame? If all the heavy parts cannot hold the car together how can the brake pipes be expected to hold up? Why not mount it as a package system on a strong bracket so that if one part moves all move.

ABLC (Load Compensating) Freight Brake Equipment

In 1948 Mr. Stevens of the Illinois Central presented a paper describing the ABLC brake installed on 400 I. C. hopper cars. Since that time road trials have been conducted under the auspices of the A.A.R., and the manufacturers have almost completely redesigned the equipment.

When the AB brake trials were conducted by the A.A.R. in 1933 the braking ratio used was 60 per cent empty and 18 per cent loaded, these values being selected as representative of most cars in service at that time. As car designs became more efficient with a corresponding increase in gross to tare ratio, it became necessary, within four years, for the A.A.R. Brake Committee to consider the next step to stop the continued lowering of braking force on loaded cars. They recognized that 20 per cent loaded braking ratio had been accepted for many years by railroading experts as a desirable minimum and that an even higher minimum would be desirable at higher operating speeds.



Improvement in stopping distances on a 1.75 per cent descending grade with the ABLC-equipped train having a loaded-car braking ratio of 30 per cent over a single-capacity brake with a loaded-car braking ratio of 18 per cent

The most expedient course open with a single capacity brake was to increase the empty braking ratio and after considerable deliberation the committee reluctantly agreed to permit an increase to 75 per cent with full knowledge that this would result in an increase in train shocks. At the same time the recommended practice was changed to permit a minimum of 18 per cent braking ratio on a fully loaded car.

Since that time most freight cars built have had the empty braking ratio close to the 75 per cent maximum, and even so, many have had the loaded braking ratio below the 18 per cent minimum recommended. The percentage of both 50-ton and 70-ton hopper cars having loaded braking ratios under 18 per cent has increased substantially in the last 20 years. Because of the trend toward lowering the loaded car braking ratios and the increase in spread between loaded and empty braking ratios, the ABLC brake was developed. It accomplishes four major functions:

1.—Permits the full utilization of light weight cars with the empty and loaded braking ratios remaining well within present A.A.R. recommendations.

2.—Produces more uniform braking with reduced shock in trains of mixed empty and loaded cars.

3.—Provides the same stopping distances of loaded trains from higher speeds than now obtained with trains of single-capacity brakes.

4.—Permits grade operation of loaded trains with a much greater margin of reserve for stopping than now exists.

In a train of mixed empties and loads during an emergency stop from 10 m.p.h., the coupler forces were only about half as much with the ABLC brake as with the AB. The road trials of the ABLC brake were conducted by the A.A.R. on the same locations used for the AB brake tests conducted by the A.A.R. in 1933. The test schedule was patterned after that used in 1933 and as far as it was practical to do so, the 1948 tests duplicated those made with the AB brake.

The first series of tests employed 150 empty cars. Service and emergency stops were made from speeds ranging from 5 to 40 m.p.h. in approximately 5 m.p.h. steps. Fifty of the cars were then loaded with coal and re-assembled in the train to make a consist of 25 loads, 25 empties, 25 loads and 75 empties. Test runs were repeated covering the same speed range. The remaining 100 cars were then loaded with coal and similar tests were made with an all-loaded 150-car train. The empty car braking ratio was 50 per cent and the loaded was 30 per cent. These values compared with 60 per cent empty and 18 per cent loaded for the AB cars tested in 1933.

The ABLC brake performance was satisfactory throughout the complete series of tests. Brake pipe and brake cylinder pressures, slack action, speed, and stopping distances were accurately recorded. On the 1948 tests, the amount of slack shocks were never greater, and in most cases were less, than those recorded on the AB brake trials. With the mixed train of empties and loads, the drawbar forces were very much less than had obtained with the single capacity brake. This had been expected due to the great decrease in the spread between the empty and loaded car braking ratios. Even with the loaded car train, where the braking forces were almost 50 per cent higher than during the loaded car train tests in 1933, the ABLC train slack shocks had not increased.

The stopping distances with empty trains were longer, as was to be expected because of the lower empty car braking ratio provided with the ABLC brake. The stopping distances for the mixed trains were about the same as for the single capacity braked cars. The loaded car train showed shorter stops for the ABLC braked cars, the difference in distance increasing as the speeds increased.

The first grade test was made with the 150 empty car train. The grade averaged 1.8 per cent for about 11 miles. The empty train brake performance on that grade compared favorably with a similar run with AB braked cars made in 1933. Two tests were made using the loaded car train, the first with the retaining valves set in 10-lb. retained position, and then repeated with the retaining valves set in slow direct exhaust position. The 150-car loaded trains tested in 1948 weighed 11,000 tons, whereas in 1933 a train of only 100 cars having a gross weight of only 8,000 tons had been taken down this same grade.

Although the 1933 test demonstrated that a heavy tonnage train could be controlled properly on steep grades, the reserve in brake pipe pressure would not have been adequate had the grade been longer. The amount of reserve brake pipe pressure at the rear of a long train during grade descent is considered, by those familiar with heavy grade braking, a means of determining the adequacy of the brake. With the 11,000-ton 1948 test train, which was 37 per cent heavier, the brake pipe pressure at the foot of the grade was 21 per cent higher than with the AB single capacity brake, even though the slow direct exhaust setting had been employed for the retaining valves. This demonstrated greater safety and an added economy for the ABLC brake.

Changes made in the ABLC equipment over that furnished for the I. C. hopper cars included a complete change in the weighing mechanism and brake cylinder and a modification of the compensating valve which involved a new body and pipe bracket. No functional changes were made in the equipment so that the original piping diagram and diagrammatics are still substantially correct.

In redesigning the compensating valve the first consideration was to reduce friction and false travel in those details which establish the position of the weighing beam fulcrum. The positioning piston, the compensating piston follower, and the two packing cups were changed to lower the friction; the roller was added to the positioning piston shaft to contact the compensating lever and he cam slope of the lever changed accordingly; and the operating lever shaft was increased in diameter, changed to a non-rusting material and carried in bronze bearings. At the same time an escutcheon plate indicator was added to the pipe bracket to give an external indication of the spring value for which the adjusting cam is set; the compensating body was strengthened to offset some flange breakage experienced with the original vintage, and a further body change was made to provide additional wrench clearance around one of the mounting bolts. The body gasket was changed slightly to help it remain in place when mounting a body portion on a pipe bracket.

The original standard weighing gear was made for hopper car mounting, with the compensating valve directly over the weighing gear and had the disadvantage of requiring installation to close limits to avoid misalignment and binding. In making an application to a gondola a newer design which is more compact and yet is suitable for universal mounting was worked out. With this arrangement the compensating valve pull rod operates the weighing gear hook through rotation of a lever shaft. A swivel joint in the pull rod gives additional flexibility.

Inspection of the I. C. cars showed need for improvement in the slack adjuster pilot valve, the indicating cylinder, and the 7⅝ in. packing cup. All pipe connections to the non-pressure head were eliminated and means for removing the non-pressure head without interference from the release spring was provided. The slack adjuster pilot valve, mechanically operated by the 7⅝-in. piston rod in the old cylinder, has been replaced by a pilot piston which uncovers a port to the slack adjuster operating pipe when permitted to travel far enough by the pilot lever which stops against the main cylinder piston. The piston-type indicator has been replaced by a diaphragm-type indicator which

operates more dependably at low pressures. The 7⅝-in. packing cup has been changed to a conventional type, sealing at the outer skirt instead of at the outer skirt instead of at the center. A spring cage has been added at the non-pressure end which seats against the hollow rod collar when the non-pressure head is removed. This simplifies maintenance of the 7⅝-in. packing cup and permits the non-pressurehead to be handled separately from the piston and rod assembly when desired.

The report was prepared by G. L. Cotter, director of engineering, Westinghouse Air Brake Company.

24-RL Brake Equipment Troubles and Remedies

Since the advent of the 24-RL brake equipment, which has been in service approximately six years, changes have been found necessary due to certain service operating conditions, which could not be foreseen during development. The changes made are listed below for ready reference before going into the subject.

1. *Independent Application and Release Portion:* When the 24-RL equipment was first adopted practically all locomotives consisted of two units and the overall length was such that the quick release feature was satisfactory. Later locomotives of three and four units became common. For this reason it was found desirable to change the Independent Application and Release Portion to provide local venting of control pipe number 16. About the same time, the double check valve in the portion was improved by incorporating a retaining ring to cage the check valve and associated spring.

2. *Accelerated Release Ball Check:* The accelerated release ball check in series with the rubber seated valve was removed from the D-24 control valve. To compensate for the omission of the ball, the insert or stop in the cover was lengthened. The check valve spring force was increased slightly.

3. *D-24 Control Valve Service Piston Return Spring Cage:* A new spring cage which resulted in the normal release position of the service piston and slide valve being moved forward 1/32 in. was applied to all D-type control valves.

4. *Release Interlock Spring:* Spring, Pc. 524014, replaced Pc. 513143 to provide more spring force.

5. *S-40 Type Independent Brake Valves:* Changes were made in the upper spring cage to eliminate vibration and loss of brakes due to improper handling. The release valve capacity was reduced to prevent unintentional release of the engine brakes by foreign particles becoming lodged under the release valve.

The troubles listed in this paper are caused either by normal wear of the working parts, lack of proper maintenance, testing, inspection or improper handling during transit and storage. As it is not good practice to make repairs and adjustments to the valves while on a locomotive because of the possibility of dirt getting into the valve parts, recommendations in general are made to replace complete portions when difficulties are experienced. The repairs should then be made at the repair bench where the necessary attention can be given to cleanliness as well as making the proper repair.

1. *Locomotive Brakes leak off with Automatic Brake Valve Handle in Lap Position.* Causes:

A.—Leakage in Pipe *16* or displacement reservoir pipe number 3. Remedy—Repair leaks or replace displacement reservoir diaphragm.

B.—Leakage at inshot valve exhaust can be caused by defective magnets are operated. Remedy—Replace relay valve portion.

C.—Leakage at K-3 switch. Remedy—Replace K-3 switch.

D.—Intermittent leakage at inshot valve when relay valve magnets art operated. Remedy—Replace relay valve portion.

E.—Ruptured diaphragm of H-24 relay air cutoff valve allowing pipe *16* air to flow to atmosphere out of exhaust port. Remedy—Replace cutoff valve.

F.—Leak at independent brake valve exhaust. Remedy—Replace independent application and release portion.

G.—Leak at *8* port on control valve or straight air pipe exhaust port or *21-B* magnet exhaust. Remedy—Replace independent application and release portion.

H.—A blow at exhaust port *10* on control valve allowing the brakes to release. If brake pipe pressure does not increase, replace service portion. If brake pipe does increase, replace rotary valve portion of brake valve.

2. *Relay Valve Exhaust Leakage:*

A.—Leakage with brakes released—Cause—Leaking supply valve in relay valve. Remedy—Replace relay valve portion.

B.—Leakage with brakes applied—Cause—Leaking exhaust valve. Remedy—Replace relay valve portion.

C.—Intermittent exhaust leakage with brakes applied can be caused by leakage of the supply valve or leakage of Pipe 16 or Pipe 3 pressure or a defective electro-pneumatic master controller, if electric brakes are used. Remedy—Repair Leakage as indicated or replace master controller.

3. *Independent Brake Valve Operation:*

A.—If the brake cylinder pressure is too low, the cause is the self-lapping portion main spring broken or improperly set. Remedy—Replace broken spring or properly set brake valve for pressure required. If the brake cylinder pressure builds up to main reservoir pressure, the locking screw is turned in too far. Remedy—Back out locking screw to proper position.

B.—*Independent Brake Valve Leakage:*

a. Leakage with brakes released. Cause—Leakage at supply valve of self-lapping portion. Remedy—Replace independent brake valve or self-lapping portion.

b. Leakage with independent brakes applied causing leakage of the exhaust valve of self-lapping portion. Remedy—Replace brake valve or self-lapping portion.

C.—*Fluctuation of locomotive brake cylinder pressure:* Cause—Defective self-lapping portion. Remedy—Replace brake valve or self-lapping portion.

D.—*Actuating valve leakage as indicated by blow at side of brake valve:* Cause—Supply valve leakage. Remedy—Replace independent brake valve.

E.—With Rotair valve in freight position and independent brake valve handle in release position, a leak at the emergency valve exhaust is caused by the emergency valve not seating properly. (This valve is the controlled emergency nullifier in the independent brake alve.) Remedy—Change Independent Brake Valve.

4.—*Improper Automatic Brake Valve Operation:*

A.—With brake valve in electric or automatic running position or automatic lap: Leakage constant at self-lapping portion exhaust. Cause—Leaky supply valve. Remedy—Change rotary valve portion or self-lapping portion.

B.—Brake valve in electric application and intermittent blow at self-lapping exhaust. Cause—Leaky supply valve. Remedy—Change Rotary Valve Portion or self-lapping portion.

C.—Brake valve in electric application position and a steady blow at self-lapping portion exhaust. Cause—Leaky exhaust valve. Remedy—Change rotary valve portion or self-lapping portion.

D.—Brake valve in automatic lap and a steady blow at brake valve exhaust is caused by leakage around equalizing discharge valve on equalizing piston portion. Remedy—Replace equalizing piston portion.

E.—With brake valve in any position and a blow out of exhaust port of filling piece portion is caused by leakage around brake pipe cutout cock key. Remedy—Replace filling piece portion.

F.—*Failure of brakes to release.* Causes:

a. Cut-off valve in automatic brake valve fails to reseat. Remedy—Change service application portion.

b. Service application piston fails to reseat due to high friction. Remedy—Change service application portion.

c. A blow at wasp excluder of cut-off valve on H-24 Relayair valve unit is caused by leaky grommet in cut-off valve. Remedy—Change Cut-off Valve.

G.—Cannot hold locomotive brake off by depressing independent brake valve handle while making automatic brake application. Cause—Choke *S* stopped up in D-24 control valve pipe bracket or ruptured diaphragm *284* in independent application and release portion. Remedy—Clean Choke *S* or replace independent application and release portion.

H.—With a 15-lb. brake pipe reduction with a single locomotive and the brake valve placed in lap position for a few seconds and then moved to running position, the brake cylinder pressure would increase. Cause—Accelerated release valve struck open. Remedy—Change emergency portion.

I.—1. When brakes apply, then release on locomotive with automatic brake valve in lap or service position.

a. Cause—Leakage of release valve piston seal or stuck piston.

b. Check valve, Reference 287, Pc. 515215, held off its seat. Remedy—Change application and release portion of control valve.

2. When brake cylinder pressure fails to build up to standard value with a full service application. Cause—Improper setting of safety valve. Remedy—Replace safety valve. This can also be caused by failure of auxiliary reservoir to be fully charged.

J.—Defective feed valve (stuck open allowing main reservoir pressure to flow to brake pipe). Remedy—Change feed valve.

K.—Blow at automatic brake valve equalizing exhaust after reducing brake pipe pressure below 70 lb. with an A unit operating with a B unit. Cause: Hostlers controls cut in on B unit. Remedy—Close brake pipe charging valve cutout cock on B unit.

H-24-C Relayair Valve Unit—overspeed suppression valve inoperative—automatic application of brakes knocks out PC switch. Remedy—Replace suppression valve.

The report was presented by a committee of the St. Louis Air Brake Club, E. W. Erisman, chairman, general road foreman of engines and superintendent of air brakes, Wabash.

Discussion

W. E. Vergan, superintendent air equipment and Diesel operation, M-K-T, proposed that a committee be formed from the Air Brake Association to study standardization of air brake devices on Diesel locomotives and to gather information and to make suggestions on 24 RL equipment to submit to a subcommittee of the A.A.R. His proposal was adopted.

Elimination of Moisture from Brake Systems of Diesel Road Locomotives

Since the meeting last year, a number of tests have been made on a 2,000-hp. passenger A unit produced by builder A. In general the comments on this unit will apply to the same builder's 1,500-hp. road units.

As the locomotive was originally piped, the location of the cooling unit between the first and second main reservoirs did not provide for adequate air circulation; therefore, this cooler was removed and replaced by a fin-tube, multiple-pass aftercooler, located directly above the No. 1 main reservoir, on the right-hand side of the locomotive as shown in Fig. 1. At the same time the check valve between the first and second main reservoirs was relocated inside the engine room. It was then at the high point of the piping between the reservoirs, where it would not be a water trap. The latest units manufactured by this builder have a multiple-pass fin-tube cooler, not of the same design covered by these tests, but similarly located.

For a new system it is recommended that, if possible, the flow of condensed water be in the direction of the air flow to minimize the possibilities of carry over. In this particular case, where an existing design was to be modified, it was thought acceptable to install the aftercooler so that it drained back into the No. 1 main reservoir, since an automatic drain valve was not used. Also, it was felt that the amount of radiation provided between the compressor and the No. 1 main reservoir in the original design was adequate.

From the test data a chart was prepared showing temperatures for the following four arrangements with comparable air flow:

A. The original design having the shrouding around the reservoirs, and the cooling unit between reservoirs.
B. The original design with the shrouding removed.
C. The aftercooler installed at the side as mentioned above, the shrouding in place but with an opening cut in it for the aftercooler.
D. The aftercooler installed, and the shrouding removed.

The curves show progressively improved performance. The best condition, arrangement D, resulted in temperatures of 5 deg. F. above atmosphere at the outlet of the aftercooler, and 3 deg. F. above atmosphere at the outlet of the No. 2 main reservoir. Air flow was approximately 40 cu. ft. per min., which is near average for passenger service. These temperatures are good, and show a marked improvement over the original design.

To illustrate the effect of air demand on a cooling system, temperature records of four tests using arrangement D were plotted on a second chart. Two were standing tests, and two were running tests. On the final test the air demand was near 73 cu. ft. per min.; one A unit was hauling a ten-car passenger train, the weather was rainy, requiring frequent use of the sanders and windshield wipers, in addition to the normal requirements of the air brakes, steam heat boiler horn control air etc. From the tests it may be concluded that the modified cooling system is adequate for all normal service.

Testing of New Designs

The first of the later design locomotives tested was a 2,250-hp. passenger A unit produced by Builder E. The initial cooling coils are located on the roof of the locomotive, the sumps are on either side of the engineroom, and the two main reservoirs are crosswise of the locomotive, just ahead of and just behind the tanks under the frame.

Extensive tests were made on this locomotive during weather which was for the most part overcast, and under these conditions the roof-cooler was extremely effective. How well this cooler will perform on a bright sunny day could not be told from the tests made, but it may be expected that the coolers will be less efficient when exposed to the direct rays of the sun.

There was a temperature rise of some 20 deg. F. between the aftercooler and the sumps during the running tests, which nullified much of the effectiveness of the roof-cooler. The temperature increase between the cooler and the sumps for the standing tests is considerably less because of the lower temperature in the engineroom when the engines are not under load. The sumps were effective water collectors, and accounted for approximately 80 per cent of the total volume of water recovered.

Isolation of the sumps and associated piping from engine room temperatures would improve the effectiveness of this cooling system. Shielding of the roof coils from the direct rays of the sun would also improve performance.

There was some question as to whether compressor loading affected temperatures in the system for the same air output. For example, would a compressor operating at 250 r.p.m., 100 per cent loaded, heat the air more than one operating at 390 r.p.m., 67 per cent loaded, or 540 r.p.m., 50 per cent loaded? Under these conditions it was found that the load and unload temperatures at the compressor discharge varied widely; however, there was little difference in temperature at any point in the systems beyond the roof-cooler.

Standing tests were made with the compressor running 100 per cent loaded in various throttle notches. At an air flow of 45 cu. ft. per min., the temperature at the inlet of the No. 2 main reservoir where auxiliary air is taken off was 24 deg. F.

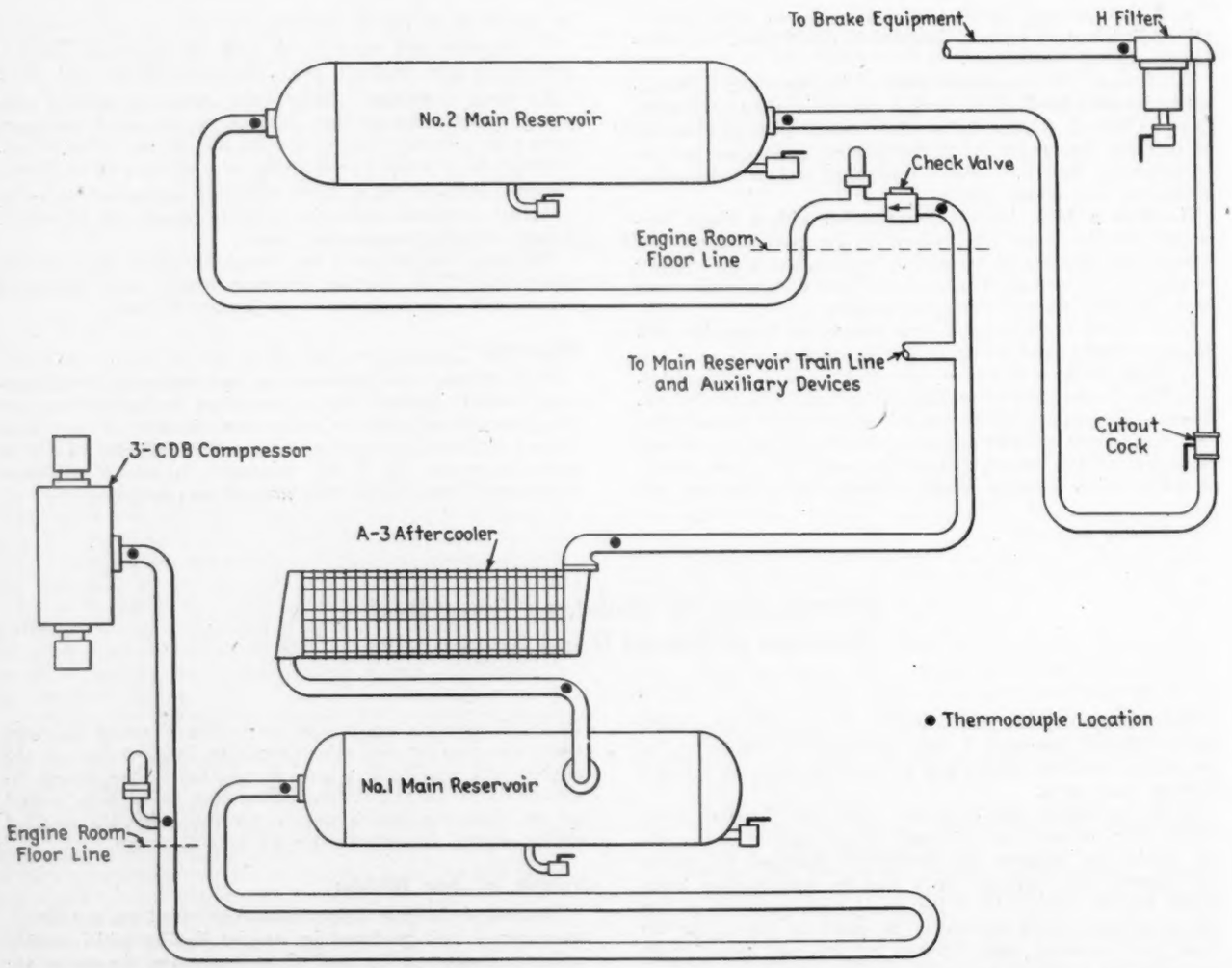


Fig. 1—Modified design of the main reservoir cooling system on a 2,000-hp. passenger A Unit

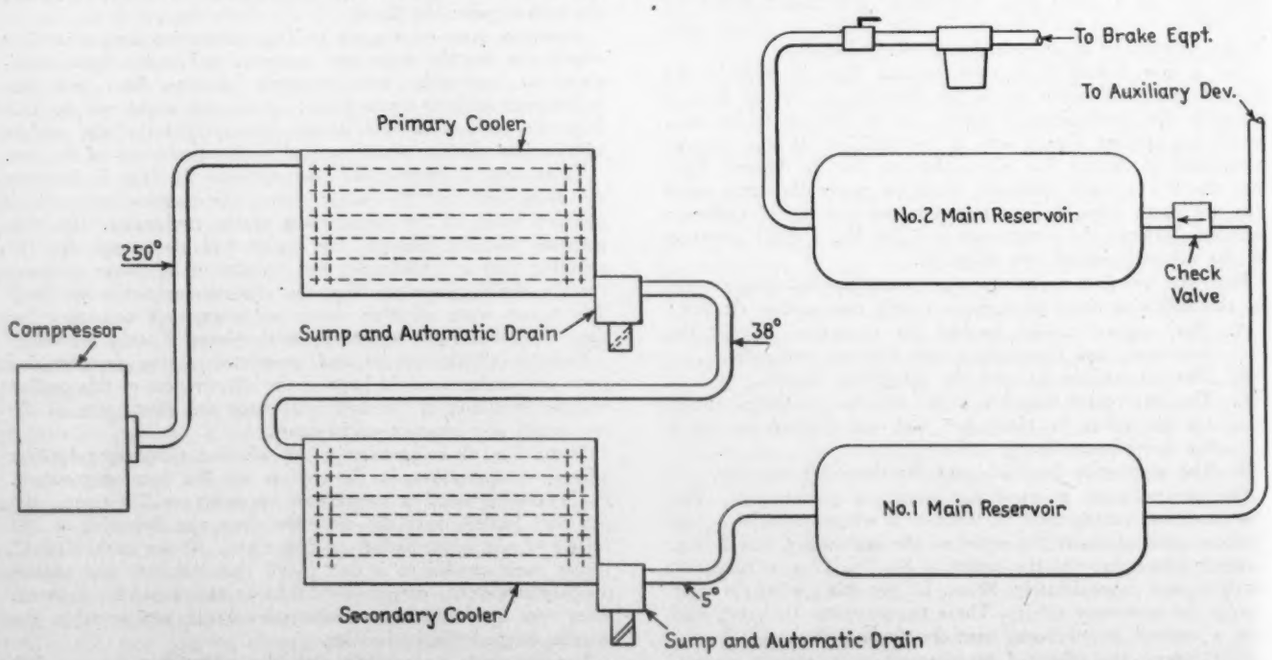


Fig. 2—Suggested design for main-reservoir cooling system where the reservoirs must be located in a warm area of the locomotive—All cooling is done between the compressor and the first main reservoir—Temperatures shown are degrees above atmospheric with an air flow of 75 cu. ft. per min.

above atmosphere, and at the outlet of the No. 2 main reservoir, 14 deg. F. above atmosphere. Some improvement in the cooling system of this locomotive is indicated in order to reach a condition of not more than 5 deg. F. above atmosphere at the discharge of the No. 2 main reservoir with an air flow of approximately 50 cu. ft. per min.

Both running and standing tests were run on a 2,000-hp. freight A unit of Builder F. One of the standing tests simulated the most severe conditions anticipated with a freight locomotive, that is, approximately 75 cu. ft. per min. air flow required for pumping up a train while standing

It is of interest to note that the temperatures for the standing tests at approximately 36 cu. ft. per min. air flow were somewhat lower than for the running tests with 24 cu. ft. per min. flow. It can be assumed that the air surrounding the cooling units is at a higher temperature when the locomotive is under load, probably due to the heat given off by the traction motors of the lead truck. The amount of cooling surface appears to be adequate, but the atmospheric air circulation around these units should be improved. This matter of air circulation around cooling units is of paramount importance and must be given careful attention. It is not always possible to predict results with any given arrangement; therefore, tests should be made as soon as possible on new designs to permit modifications.

A Problem of Design

Some builders are now faced with the problem of locating main reservoirs inside the engineroom due to space requirements of other components under the frame and in the spaces normally used for radiating units. Where this condition exists a suggested radiating system would be that shown on Fig. 2 wherein all of the cooling is done between the compressor and the first main reservoir. The cooling system is divided into two sections, each provided with a suitable sump and automatic drain valve. The system shown here was calculated for an air flow of 75 cu. ft. per min. with an initial temperature of 250 deg. F. above atmosphere, and a discharge temperature at the secondary cooling unit of 5 deg. F. above atmosphere. The two cooling units consist of 100 ft. of 1¼-in. extra heavy iron pipe, or equivalent, with suitable sump and automatic drain valve for each.

The cooling piping should be arranged so that moisture flow is in the direction of air flow for greatest efficiency. More radiating pipe is required than in the usual arrangement, since advantage cannot be taken of the cooling effect of the main reservoirs. It is most important that the cooling units be exposed to cooling air at atmospheric temperature, and that proper provision be made for collecting and draining moisture before the compressed air is reheated in the reservoirs and piping to them.

The problem is not a new one, since similar conditions were found to exist on certain steam Mallet locomotives where the reservoirs were mounted near the fire box and compressors had to be mounted on the pilot of the locomotive. A cooling system generally similar to the one presented here has been used successfully on these locomotives for many years.

The trend in locomotive design and operation is toward increased use of air and air-operated devices. Also, the horsepower per unit is increasing. These two factors have resulted in increased air demands on the main reservoir systems of the newer units. Whereas it was generally considered that an air flow of 25 to 35 cu. ft. per min. was the average which could be required of a system, the tests which have been run the last year indicate that our estimates should be revised upward. An average of 40 to 50, and a maximum of as high as 75 cu. ft. per min. for a few passenger running conditions are closer to actual requirements. For freight standing conditions, an air flow of 75 cu. ft. per min. for a lmited time should be considered.

A protected air supply, or reservoir, should always be provided for the brakes. This is usually accomplished by putting a check valve ahead of this reservoir and by connecting the main reservoir train line and supply for auxiliary devices ahead of the check. The auxiliary devices usually require dry air, and in some cases it may be necessary to use the radiating effect of the No. 2 main reservoir to get sufficient cooling. If so, a third main reservoir, protected by a check valve, can be used as a supply for the brakes. The auxiliary air supply can be taken off between the No. 2 and No. 3 main reservoirs. Whatever arrangement is used, the air temperatures should be low enough to prevent moisture condensation beyond the last water collecting device.

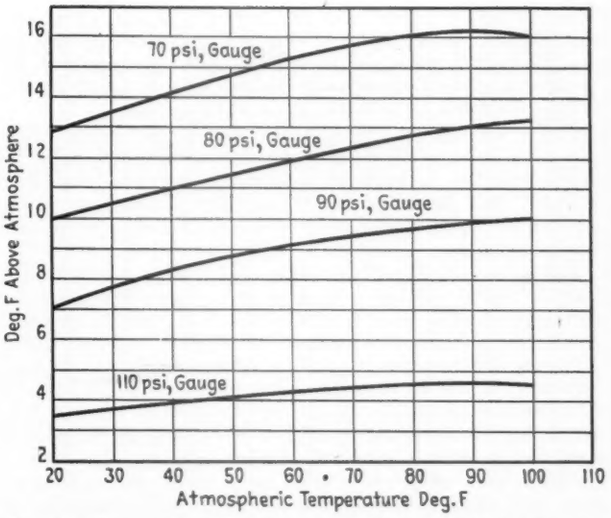


Fig. 3—Temperatures above atmosphere to which air must be lowered before leaving cooling system to prevent moisture condensation when pressure is reduced—In each case the pressure is lowered from 130 lb. per sq. in. to that shown on the appropriate curve

Considering for a moment the design of aftercoolers, several factors should be mentioned. Multiple passes, as opposed to series passes of cooling pipe should be used where possible for two reasons: Multiple passes are less likely to become obstructed sufficiently to interfere with the operation of the system and, when properly designed, multiple passes provide for lower air velocity and therefore reduce the possibility of moisture being carried along in the air stream. The tubes of such aftercoolers should be so designed as to make them easily removable for replacement in the event of damage or periodic cleaning.

To obtain greatest effectiveness from multiple-pass aftercoolers, they should be so designed as to distribute air flow equally among the tubes. Where space limitations exist, finned tubing of efficient design can provide greater radiation in a given space in a ratio of 2 or 2½ to 1 over plain tubing or pipe.

A Yardstick for Comparison

Fig. 3 is an indication of how low main reservoir air temperatures must be reduced. The chart shows how close to atmospheric temperature the compressed air temperature must be lowered in order to prevent condensation of moisture in the brake pipe. This is shown for various atmospheric temperatures. Curves have been plotted for reduced pressures of 70, 80, 90 and 110 lb. per sq. in., with an original main reservoir pressure of 130 lb. per sq. in. These figures will apply whether the air is to be used for air brakes, controlair, steamheat boiler, or other purposes.

It would be desirable to provide a cooling system adequate to handle the maximum air requirements, reducing the temperatures to the limits indicated on this chart. It is realized that this might not be economically feasible, but if cooling systems are designed to handle the average air requirements in a proper manner, then special provision could be made for additional cooling in the few cases requiring excessive quantities of air over long periods. High air requirements often occur at initial charging, but the cooling system at the start is near atmospheric temperature, when the efficiency of the system is best. For ordinary train charging conditions, a cooling system which can handle 40-50 cu. ft. continuously at the recommended temperatures should be satisfactory.

The problem of cooling system design is quite involved, because of the large number of variables which influence results. A few of these and their effects are obvious. Whether the locomotive is running or standing affects the air flow around the cooling units. While the locomotive is standing, a crosswind will have pronounced influence on the temperature pattern.

The weather in general also can influence results where rain, cloudy skies, bright sun and various degrees of humidity are encountered. As we have shown, the air requirements of the system can also influence results; however, this particular variable can be controlled to some extent on standing tests.

During the test program, difficulty was experienced in collecting water because the cooling units, reservoirs, etc., were not always installed to drain to a common point. It is important to install the system so that drainage is not influenced by the level of the track which would cause the locomotive to tilt one way or another.

The load imposed on the locomotive engine, generator, and traction motor, will have an effect on temperatures, since the heat in the engine room and under the frame will be generally greater as the load is increased.

Despite the large number of variables, sufficient tests have been run to provide a rather complete picture of fundamental requirements for proper main reservoir cooling systems. You cannot get something for nothing, however, and the little extra spent for a well designed and properly located main reservoir cooling system will pay big dividends in the end by reducing air brake maintenance, and eliminating many road failures due to freezing, etc.

This report was a presentation of the Manhattan Air Brake Club.

Discussion

L. D. Hayes, brake equipment engineer, N. Y. C., said that the big pressure drop should occur just before the No. 1 main reservoir. If some internal frosting occurs it will reach equilibrium. Considerable radiation is needed between the No. 1 and No. 2 main reservoir to do any good.

H. I. Tramblie, air brake engineer, C. B. & Q., said that the original four-unit FT locomotives received by his road had bad radiation. Considerable moisture occurred in the brake equipment and on the piping several cars behind the locomotive, freezing 2 and 3 cars back. A new main reservoir and a new arrangement, putting the radiation units outside, resulted in a temperature of the air at the last main reservoir approximately at the outside temperature. The moisture is accumulated in the No. 1 and No. 2 main reservoirs and in the sump. He thought the main difficulty with the brake system is in the oil; it can't be eliminated, and it clogs the feed valves and other brake equipment necessitating cleaning. An oil separator is more urgently needed than the elimination of moisture. If the oil could be eliminated before reachng the operating equipment, it would be desirable to request the I.C.C. to extend the cleaning interval requirement to one year.

F. C. Wenk, general mechanical instructor, Atlantic Coast Line, reported that his road spent $53,000 to eliminate moisture to prevent freezing. They have had Diesels since 1939 and still have the moisture problem. They also have an oil problem. Until the $53,000 was spent the engineer and fireman at times could scarcely see each other due to the oil fog in the cab. He asked why the compressor should run at 800 r.p.m. when little air was needed and when the throttle was in position 1 or 2, a time when the air is normally needed, the compressor drops in speed. He advocated a magnetic clutch.

* * *

Baldwin photo

Serious Car Problems Discussed at C.D.O.A. Annual Meeting

Major emphasis is placed on getting more cars, stepping up maintenance and using all cars more intensively in order to meet demands of the present national emergency

G. H. Wells
President
(Assistant to superintendent car department, N.P.)

A PRIMARY warning sounded at the annual meeting of the Car Department Officer's Association at Chicago, September 18 to 20, inclusive, was that car men are again called upon to save the nation, as well as industry, in the present critical car shortage by somehow finding more cars—new ones, old ones, good ones, bad ones—loading them to the limit, instituting "around the clock" maintenance and doing everything else necessary to reduce turn-around time and keep the cars rolling. This was the sentiment voiced in an address by Joseph H. Hays, counsel, Association of Western Railways.

Similar views were expressed somewhat differently by W. W. Judson, operating vice-president, Northern Pacific, who also stressed the importance of car design in reducing maintenance and promoting safety in high-speed operation. He urged greater care to avoid car damage by mechanized equipment in loading and unloading; definite support by all railroads of the present organized efforts to reduce brake pipe leakage, particularly at AB-brake covers; more intensive work in providing the right kind of waste and all-weather oil essential to minimize hot boxes. Mr. Judson mentioned the need for more adequate personnel training and closed his remarks with an appeal for railroad men in all departments to promote safety, improve service and reduce costs.

Committee Reports

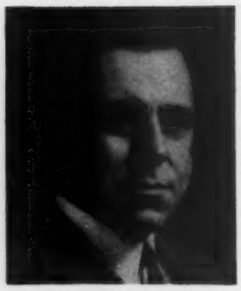
There were two business sessions of the C.D.O.A. on each of the three days except September 19, the afternoon of which was devoted to an exhibit of railway electrical equipment and supplies presented by the Railway Electric Supply Manufacturers' Association. At each of the meetings, President G. H. Wells, assistant to superintendent, car department, Northern Pacific, presided and adhered strictly to the promise in his opening address that full discussion would be encouraged and time taken to hear all differences of opinion. The total registration of railroad men at the convention was just under 400 and they came from all parts of the country.

Standing committee reports and the chairmen who presented them were as follows: Air-Conditioning Equipment—Operation and Maintenance, C. S. Albright, supervisor electrical equipment, N. Y. C., Cleveland, Ohio; Wheel Shop Practices, R. L. Frame, wheel shop foreman, N. Y. C., Beech Grove, Ind.; Car Lubrication, G. R. Andersen, superintendent car department, C. & N. W., Chicago; Interchange and Billing for Car Repairs, by R. W. Hollon, mechanical inspector, C. B. & Q., Chicago; A. A. R. Loading Rules, J. Krupka, general car foreman, C. B. & Q., Chicago; Qualifications and Selection of Car Department Supervision, Chairman R. E. Baker, assistant general manager, B. & M., Boston, Mass. (report read by K. H. Carpenter, superintendent car department, D. L. & W., Scranton, Pa.); Cleaning and Painting of Passenger Cars at Terminals by R. Middleton, painter foreman, N. Y. C. & St. L., Chicago; Analysis of Train-Yard Operation to Improve Performance, G. J. Flanagan, general car inspector, N. Y. C., New York.

Election of Officers

At the concluding session, the following new officers and board of directors were elceted for 1951: President, J. A. Deppe, superintendent car department, C., M., St. P. & P., Milwaukee, Wis.; vice-presidents, W. N. Messimer, general superintendent of equipment, Merchants Despatch Transportation Corp., Chicago; A. H. Keys, superintendent car department, B. & O., Baltimore, Md.; R. Schey, general superintendent car department, N. Y. C. & St. L., Cleveland, Ohio; J. F. Likarish, master car builder, G. N., St. Paul, Minn.; secretary-treasurer, F. H. Stremmel; assistant to secretary, A. A. R., Mechanical Division, Chicago. The new board of directors includes the following: J. S. Acworth, assistant vice-president, General American Transportation Corp., Chicago; G. R. Andersen, superintendent car department, C. & N. W., Chicago; W. P. Elliott, general car foreman, Terminal R. R. Assn. of St. L., St. Louis, Mo.; L. H. Gillick, vice-president, Vapor Heating Corp., Chicago; E. E. Golden, supervisor of A. A. R. inspection and accounting, L. & N., Louisville,

J. A. Deppe,
Vice-President
(Superintendent car department, C.M.St.P.& P.)



W. N. Messimer,
Vice-President
(General superintendent equipment, Merchants Despatch Transportation Corp.)

A. H. Keys,
Vice-Pres.
(Superintendent car department, B.& O.)

F. H. Strommel,
Sec.-Treas.
(Assistant to secretary, Mech. Div., A. A. R.)

Ky.; H. A. Harris, master car builder, G. M. & O., Bloomington, Ill.; H. L. Hewing, superintendent of interchange, Chicago Car Interchange Bureau, Chicago; P. J. Hogan, supervisor car inspection and maintenance, N. Y., N. H. & H., New Haven, Conn.; F. R. Hosack, general superintendent motive power, C. R. I. & P.; Chicago; J. E. Keegan, chief car inspector, Pennsylvania, Chicago; H. S. Keppelman, superintendent car department, Reading, Reading, Pa.; J. A. MacLean, Jr., president, MacLean-Fogg Lock Nut Co., Chicago; G. E. McCoy, assistant chief of car equipment, C. N., Montreal, Que.; J. P. Morris, general manager, mechanical, A. T. & S. F., Chicago; L. Richardson, assistant general manager, N. Y. S. & W., Paterson, N. J.; J. J. Root, Jr., Union Tank Car Company, Chicago; H. H. Urbach, general superintendent motive power and machinery, C. B. & Q., Chicago; F. J. Wade, secretary and superintendent, Crystal Car Line, Chicago; G. H. Wells, assistant to superintendent car department, N. P., St. P., Minn.; J. A. Welsch, superintendent of equipment, I. C., Chicago.

Air Conditioning Operation and Maintenance

For the past two years, this committee has discussed at some length the methods used in obtaining cooling in the body of the car. In 1948 we discussed the method using a compressor and Freon or F-12 as a refrigerant. In 1949 we discussed the manner of obtaining cooling with a steam ejector using water as a refrigerant. In both cases we concentrated our efforts on the cooling of cars and some of the facilities required. We did not discuss the various ways in which the equipment is made to perform its duties at the proper time.

While we cool a car during certain portions of the year, it is also necessary to heat the car during other portions of the year. In some cases, where a car travels from a northern to a southern climate, it may be necessary to do both on the same run; namely, heat the car in the northern climate and cool it when it gets into a southern climate.

Whether we cool or heat a car, this cooling and heating must be controlled. The car must be comfortably cool or comfortably warm as is required. A car which is too hot is just as uncomfortable as one which is too cold. Likewise, both heating and cooling are related to the outside temperature in that a car with an inside temperature of 70 deg. F. and an outside temperature of 100 deg. would certainly feel too cold to the person entering such a car. This difference in temperature is not alone the measure of feeling comfortable. Relative humidity, a term used to indicate the quantity of moisture a cubic foot of air can hold in suspension at any temperature, also plays a large part in our overall comfort. It should be remembered that air can hold considerably more moisture in suspension per cu. ft. at a temperature of 100 deg. than it can at 50 deg. For example, at 100 deg. F. it can hold approximately two times as much as it can at 78 deg., three times as much as it does at 66 deg., and four times as much as it can at 56 deg. We all complain about the heat when the temperature is high and the moisture content is also high. It is only when a large percentage of this high moisture content is removed that moisture is evaporated from our skin and we begin to feel cool.

As an illustration, we could be comfortable in a room having a temperature of 75 deg. and 100 percent relative humidity. We can pass from it into a room having a temperature of 80 deg. and a 67 per cent relative humidity, then into an 85-deg. temperature with a 54 per cent relative humidity, and again into a 90-deg. room with a 24 per cent relative humidity and be just as comfortable in the 90-deg. room as in any of the others.

One large user of insulated cable, stores it in a room in which the temperature is held at 115 deg. with a relative humidity of about 1 per cent both winter and summer. At this low relative humidity, the temperature must be kept high to be comfortable for the workman. We mention these illustrations to point out that reducing the temperature alone does not make a car comfortable, any more than raising the temperature, unless certain other things are considered.

In a few words, it is necessary to control a number of items to make a car comfortable in all kinds of outside temperature.

1. We must mix a certain amount of outside air with that in the car. It must be clean. We control the amount of dirt brought into the car from the outside by making this air pass through filters.
2. We determine the amount of air circulated through the car by using a motor driven fan of a given capacity.
3. We lower the temperature inside the car when we cool it and remove a certain percentage of the moisture content by passing the air over a coil containing a refrigerant, called an evaporator. The extent to which this is done is, in a general way, controlled by the capacity of the plant and the time it operates. There are other factors which enter in, but we are not in this paper concerned with them.
4. We heat the car by passing saturated steam through heating coils located inside the car, or use steam to heat a liquid circulated through coils in the car. The extent to which this is done is, in a general way, determined by the amount of radiation required. In this connection it might be added that it is not an easy matter to add moisture to the body of the car when heating a car, as it is to remove moisture when cooling the car.

Electrical Control of Cooling and Heating

Whether we heat or cool a car, some means must be provided which will communicate the heating or cooling requirements in the car to the equipment which takes whatever action is necessary. For this communication we depend on an instrument called a thermostat. The exact form, shape or type this thermostat may take will depend, to a large extent, upon the manufacturer and the function it is to perform. It may be a glass tube with a mercury column very similar to the usual thermometer. It may be a pressure type, a type using a wire resistor or a bi-metallic type. Whatever the type, it either makes, breaks or shunts an electrical circuit to start or stop either the heating or cooling.

Probably the thermostat most commonly used is the one consisting of a glass tube containing a mercury column with two wire electrodes extending through the tube to contact the mercury column as it rises and falls with change of temperature. When the mercury column rises sufficiently to contact both electrodes, it closes an electrical circuit. When the mercury column drops below the upper electrode, it opens an electrical circuit. These thermostats are made to contact both electrodes at predetermined temperatures so that the circuit may be opened or closed at any desired temperature.

By using a glass tube with a double bulb, the one above the usual bottom bulb, it is possible to make this tube perform the functions of two single thermostats. To accomplish this the upper bulb is surrounded by a heater consisting of a coil of wire wound around the bulb. This wire and the bulb is then insulated from the surrounding atmosphere. If the temperature in the car is 70 deg. F. and it is decided to have the thermostat contact at 80 deg. F., sufficient current is allowed to flow through this heater to make the mercury column contact the same as it would do if in a room temperature of 80 deg. and no auxiliary heat added.

The other types of thermostats perform the same type of duty. Perhaps the one most familiar to everyone who has thermostatic control of heating in his home, is the bi-metallic type. This thermostat depends for its operation on the expansion and contraction of a piece of metal. It performs well and accurately with years free from trouble.

The pressure type of thermostat depends upon the heating and cooling of a liquid within a bellows. The expansion and contraction of the bellows functions to perform the various operations.

Still another type depends on a length of temperature sensitive resistance wire usually wound on an open plastic spool. The resistance of this wire varies with the temperature so that its resistance is a measure of the surrounding temperature. This type of thermostat responds quickly to temperature change and has no moving parts.

Thermostat Reliability Important

Considering the important part which the thermostat plays in both heating and cooling, it is readily seen that its failure means the necessary corrective action will not be automatically initiated and consequently any action taken will be by hand and not automatically.

In the early days of car heating and later in the development of air conditioning, the most commonly used thermostat was the mercury tube. It is probably the most commonly used today in the control of car temperatures. The present-day thermostat consisting of a mercury column has been improved by modern manufacturing methods and testing and is considerably better than its previous models. It is, however, still a source of some difficulty. This difficulty consists of unwanted separation of the mercury column and failure of this separation to close. This separation is readily detected by visual inspection. A large number of the earlier control panels contained two metal posts identified as "A.C. Test." A thermostat failure could be by-passed by using a paper clip or any other available means by which these two posts could be jumpered.

The thermostat usually initiates the corrective action required by causing an electric current to energize the coil of a relay and change its controls if either added cooling or heating is required. When the necessary correction has been made, the thermostat again initiates the corrective action by opening the circuit, which in turn de-energizes the coil of the above relay, thus opening the contacts.

(*The report here included a detailed description of electric controls in both cooling and heating. It was presented by Chairman C. S. Albright, supervisor electrical equipment, N. Y. C., Cleveland, Ohio.*)

Discussion

The first speaker said it was definitely educational in fundamentals, showed the constant care necessary to minimize failures and should be distributed to all maintainers.

The chairman pointed out that train crews do not usually know what the trouble is when failures occur, but one member urged that they be taught emergency steps to keep the equipment running.

The consensus was that trainmen can help most by leaving a note in the electric control locker simply saying that a car does not heat or cool, as the case may be, and not attempting to diagnose the trouble, or worse still, try to remedy it. In fact, one member suggested that the control lockers be equipped with *OFF* and *ON* switches which can be operated from the outside and then locked to avoid any possible tampering by well-meaning but unskilled (in air-conditioning matters) trainmen.

Report on the Hot Box Situation

Records which we have studied disclose that the abnormal hot and dry weather that occurs in most states in the months of June, July and August causes a rise in hot boxes of close to 37 per cent above what is considered normal operation. It is a most difficult situation to combat, and has undoubtedly been aggravated by the sharp acceleration of freight trains out of terminals as a result of Diesel operation. It could well be influenced by poor lubricating qualities of the waste as a result of foreign matter, moisture, etc. The rather reverse situation is the fact that during the summer months very little difficulty is experienced in the operation of waste packed boxes on passenger trains. The answer is in the fact that journal boxes on passenger equipment receive, as a result of owner handling, preferred attention; namely—better grade of waste—higher percentage of retirement of waste—more frequent repacking—better maintenance of journal boxes, and the use on most railroads of *summer and winter oils*. This may or may not be a fair comparison, but it does seem to prove that with sound maintenance practices, and oil suitable to the season, waste can be satisfactorily employed as a lubricating agent regardless of high temperatures.

The reverse to high temperatures is the abnormal low temperatures during the winter months, particularly January and February, and while in part the causes for hot boxes during periods of low temperature presents a somewhat different picture, particularly the effect of moisture and the dislodgement of packing, there is hardly any question but that present car oils are failing to provide adequate lubrication qualities to meet peak weather temperatures. The function of a lubricant is to provide a film that will prevent metal to metal contact, and at the same time a circulation of the lubricant that will remove or dissipate frictional heat developed in the journal and bearing. Rapid acceleration, higher running speeds, and heavier loads, coupled with high temperatures, call for a viscosity oil that will permit a high oil travel and feed through the waste. High viscosity (heavy) oils decrease this feed and raise frictional heat. The present permissible maximum viscosity of 725 deg. for renovated and summer car oil is entirely wrong as it cannot properly function in territories with low temperatures. We are reasonably certain that seasonal epidemics can be greatly controlled by the general use of an all-year oil embracing the following requirements: (1)

A higher film strength oil with film strength additive; (2) A relatively low viscosity oil with high capillarity and high viscosity index; (3) A clean stable oil; (4) An oil which has a pour test of minus 20 deg. F.

There has been some marked activity in this direction on the part of the A.A.R. in cooperation with the Lubrication Committee, and that emergency specifications, applicable to both new and reclaimed journal box oil, have been prepared which supersede present A.A.R. Standard Specifications. These will remain in effect until such time as the research now being conducted by the Mechanical Division is completed. These new emergency specifications will go into effect January 1, 1951.

The Question of Waste

It would seem that we are finally moving in the right right direction insofar as oil is concerned. The correction of one evil, however, and failure to restore others to respectability will not have the desired or perhaps anticipated effect in improving the performance. Let us discuss the matter of waste, certainly a vital part of the box assembly. Laboratory tests made during the past year under the supervision of the A.A.R. were a good indication that a large percentage of our hot boxes are due to the wrong kind of material and combination of mixes in our journal boxes. This being true, what are we going to do about it? Continue to purchase, if any, the cheapest kind of waste; waste with poor oil absorption and retention; waste that has a tendency to roll; waste that is not thoroughly delinted; waste that contains everything from grandfather's nightshirt to Johnny's underpants? If we are really in earnest about improving our journal bearing performance, then mechanical men, those of us who are responsible for the operation; those of us who are called upon to explain to the boss, after the morning delay report has been read, had better get interested in the quality of waste that is going through our waste renovating plants.

While fairly reliable data discloses that from 75 to 80 per cent of the total waste used is processed through renovating plants, no one has been able to determine what percentage remains in circulation for long periods and consequently is laundered repeatedly. Let that be as it may, we cannot help but be impressed with the definite necessity of purchasing high quality material at the outset in order that its lubricating qualities are prolonged. Practical waste specifications drawn up today with the best of intentions cannot be forgotten tomorrow or left in the hands of purchasing agents, who may in the best interests of their company, and without realizing the seriousness of the situation, assign the order to the lowest bidder. Some railroads, we are informed, are making quite a nice showing in their lubrication costs by practicing false economy in the purchase and use of waste. Bear in mind that what one railroad or private line does effects the performance for better or worse of other roads. We rather suspect, in view of the decided necessity of reducing delays, that you will not have too much trouble in convincing your operating vice president that it is going to be economical to spend 3 or 4 cents more for waste, particularly when you prove to him that by its use his operating costs will be reduced.

Percentage of New Waste

Methods and equipment necessary in packing renovating plants to produce a satisfactory car journal packing is of great importance. Out of the work in one of the lubrication laboratories has evolved the definite need for and the method and equipment to produce a superior car journal packing by cleaning and drying the waste to a high degree. Because the renovation of journal box packing is thought of chiefly as an economic practice, its quality is often measured by an occasional visual inspection for cleanliness rather than by its fitness and ability to properly lubricate car journals, which after all is the only true yardstick of its value. The proper percentage of new waste used during the process of renovation to liven up the product and compensate for worn out material and losses is highly important.

What about the renovated waste after it is released from the renovating plant? Do we give it full protection until it is finally placed in the journal box? Is each pound of it equally saturated with oil and in the same proportion that it left the plant? Might be well to check this. Might be well to see that the vacuum sealed drums are in good order, painted, properly identified, and not leaking; that packing is not directly used from drums to journal box, but on the other hand stored in appropriate sized vats equipped with drains and sprays in order that drained off oil may be returned from whence it came. Is the old packing properly protected or permitted to stand out in the open exposed to the elements? As in the instance of oil, revised emergency specifications for new and renovated waste have been prepared, same to become effective January 1, 1951.

Waste Grabs

No one has to our knowledge ever been able to determine what percentage of hot boxes are due to waste grabs. Safe to say, it is high, and unquestionably has materially increased with changed operating conditions. Changed operating conditions, not only in regard to higher speed out of terminals and between stations, but increased disregard for the handling of equipment in terminals followed by hurried or immediate departures after trains are assembled. While hot box performance will improve with proper oil and better waste, it will continue to be throttled until sufficient time is allowed to properly service trains at stipulated terminals. While we are going about setting up A.A.R. regulations in regard to waste, oils, design and practices, why not have A.A.R. regulations in regard to the allotted time in terminals for inspection, testing of brakes, and servicing of journal boxes on departing trains, according to their length. It's not so far fetched as it sounds and the results would be far reaching. Right now, and no doubt for some time to come, the use of packing retainer springs is in a large measure the answer to controlling dislodgment of waste in journal boxes.

Speaking of devices, some of you may or may not be familiar with a journal lubricator, now running extensive tests, that embodies the use of two rollers contacting the underside of journal which are supported by springs that are in turn attached to the lugs of the journal bearing. The rollers revolve in oil and consequently set up a splashing condition that provides lubrication for the journal bearings. In a standard box results have been good.

Up to now we have talked to you about seasonal hot box epidemics—all seasonal oil—better waste and more use of it—journal bearing development—efficiency of packing renovating plants—protection of renovated waste—train yard operations and devices. All of these will be to no avail unless we take decisive and immediate action concerning the maintenance of journal boxes. Frankly, the condition that exists in this respect smells to the high heavens. Thousands of cars are operating with the contact face of box lugs worn completely through. Thousands have the box cover hinge pin hole badly worn and elongated, and as a result box covers are either falling off along the right-of-way or give little, if any, protection to the precious commodity in the box as a result of bouncing or hanging loosely. This is bad enough, but when you couple it up with a journal box, of which the front face is as rough as the Rocky Mountains, you really have a bad condition.

The A.A.R. Lubrication Committee has recently recommended a limit of 12 months on repacks. This we feel is a step in the right direction, but after that, what? Unless you provide a journal box that is everything the word implies, the box cover, regardless of pressure, cannot possibly provide the protection intended and the lubricating qualities of the waste that you have gone to considerable expense to provide will deteriorate rapidly. Get this—analysis of packing removed from boxes with worn lugs and pinholes showed that it contains as high as 28 per cent foreign matter (moisture and dirt) notwithstanding the fact that the boxes had been repacked between three and four months previous. On the other hand, tests conducted on cars with the front face of journal boxes planed smooth and with the lugs and hinge pin holes in good condition indicated the waste, after nine months of service, to contain only 2½ to 3 per cent foreign matter.

Ordinarily the average service life of a freight car is 30 years. Generally the truck sides continue in service, bar mishap, the life of the car, but what about the lugs. The answer is simple—as a result of contact from rollers and plates of box covers daily, wear progresses rapidly. This committee feels that what is necessary is, first, make it compulsory in the manufacture of truck frames or individual boxes that the front face of journal boxes be planed smooth, and that the lugs be equipped with wear plates both on the face and in the hinge pinhole. Second, that when cars are on

repair tracks for repacking under the rules, wear plates be examined and where found to be worn, they be replaced either through the means of similar plates, or by complete lugs equipped with wear plates; car owners to be properly billed for such service. Third, that these requirements become effective January 1, 1951.

(The report was presented by Chairman G. R. Andersen, superintendent car department, Chicago & North Western, Chicago.)

Discussion

In closing the report, Chairman Andersen asked that the association go on record as recommending the application of wear plates on journal-box-cover hinge-pin holes and side contacts.

George Lehnerer, superintendent car department, I. C., said that other improvements than tight-fitting covers are needed, as many boxes are found in bad shape with packing high, low, not in contact with the journal, no oil, etc. He moved that the A.A.R. be asked to set a price for oil and labor in correcting these conditions on "in date" cars received on repair tracks, but after considerable discussion this motion was voted down.

R. Schey, general superintendent car department, N. Y. C. & St. L., said that some railroads expect too much of their packing reclamation plants; that 80 per cent is an excellent return and that the A.A.R. should specify the addition of a minimum of 20 per cent new waste.

(*The report was accepted and recommendations ordered referred to the A.A.R. Mechanical Division.*)

Car Wheel Shop Practices

Reduction of wheel and axle failures can be accomplished by development of wheel and axle shops with improved shop equipment, better maintenance of that equipment and more skilled operators to produce products measuring up to the required higher standards. Such standards of work should always exceed the minimum requirements of the A.A.R.

A production shop, where the volume work is steady, is required in order to place each worker on an individual operation, thereby developing a skill which will automatically give you a high work standard. In small shops men must be used on various operations to fill out a workday and are apt to become skillful in the operations that are liked and deficient in the ones disliked. Better results are obtained through the worker being mentally conditioned and skillful on a single operation which only a high volume shop can provide. This plan, in conjunction with proper machinery and equipment, will obtain desired results.

The management of one railroad felt the best solution to this problem was centralization of wheel maintenance which would permit developing proper facilities and justify the investment required to obtain the quality of work to maximum standards. In 1945 the road took steps to centralize wheel and axle work. Modern equipment was purchased and installed in a layout that was planned in conjunction with material handling so that all floor space would be efficiently utilized. Along with this controlled flow of material through the shop, was full consideration of the comfort and safety of the employees. Several old wheel shops were eliminated in this centralization project and based upon costs of individual operations in the old shops as compared with those in the new shop, the investment in the new shop was repaid in approximately 38 months by the decrease in operating costs. The railroad not only realized the saving but was able to obtain uniformly better results by attaining and maintaining high standards of workmanship.

Sequence of Operations

In sequence of operations, the wheels are received at the shop in cradle cars. Those for stripping are unloaded on the stripping track leading to the stripping press; the cut journals and tread turners are placed on the tracks leading to the journal lathe and tread lathe. Wheels and axles are then given a rigid inspection regardless of markings or symbols on them.

Wheels are then rolled to the cleaning machine where they are revolved on a set of rollers and the center portion of the axles, between the wheels, is cleaned by wire brushes for magnetic particle inspection. The wheels are then rolled into the shop to the stripping press and demounted. After demounting, wheels are lifted by an air hoist into an elevator which raises them to a ramp. They roll down the ramp by gravity to the various bins, the scrap cast wheels in one bin, the scrap steel in another. The second hand wheels that have been inspected and found serviceable roll into a storage bin. Diversion of wheels to the various bins is controlled by switches operated by air valves at the stripping press.

Axles are carried by monorail to the centering machine storage racks. All axles are recentered on a double-end automatic centering machine, both ends being centered at the same time.

Axles are checked for the nearest predetermined sizes and delivered to the various lathes, where they are machined on the collars, journals and wheel seats. All axles that do not measure up to A.A.R. specifications are scrapped. All axles are checked for concentricity before turning. All journals are checked for seams or cracks and if any are found which cannot be removed by machining the axles are scrapped. It is important that a uniform finish be held on the wheel seats at all times as this is important for proper mounting operation. High-speed tool steel is used in machining axles. Carbide tools are not used due to the glazed finish being unsatisfactory for mounting operations.

After the axles are turned they are placed on a pallet type conveyor and advanced to the magnetic particle testing machine, thence to the journal burnisher and the mounting press.

New loose wheels are stored on a platform outside the shop and the boring mills are supplied with wheels by conveyors direct from this storage. Wheels are loaded on the conveyors with a wheel wagon. Loose wheels are not rolled by hand at this shop. Outside conveyors are covered and have a series of tubing used as heating radiators to melt the snow from the wheels in the winter season, while moving into the boring mills.

The wheel boring mills are equipped with right and left hoists. Wheels are picked up by one hoist from the inbound conveyor and placed on the machine for boring. They are removed by hoist on the opposite side and placed on an outgoing conveyor to mounting press.

Wheels Bored to Chart Size

As previously stated, axle wheel seats are turned to nearest predetermined size. Boring mill operators are furnished charts showing diameter of wheel seats on axles being worked and the wheels are bored to these charts sizes of axle dimensions with proper tolerance allowed to obtain required mounting pressure.

The tolerance used for boring cast wheels is approximately .0015 per in. of diameter smaller than wheel seat, and for steel wheels .001 per in. of diameter smaller than wheel seat. These limits will vary at times due to the condition in structure of wheels. Carbide tools are used for boring both cast iron and steel wheels. The finish bore for steel wheels is important when boring with carbide tools. A dull uniform finish must be held in the bore at all times. When the finish becomes glazed, it causes misfits regardless of the amount of tolerance used. It is possible to maintain a dull finish on steel wheels with carbide tools only if the power feeds and speeds are maintained and the right amount of metal removed with the finishing cutters.

Hardness of the hub metal also governs the amount of tolerance needed for a press fit. A wheel that has had a number of axles pressed in and out of it will need less tolerance. On the other hand skimming out the wheel bore to true up the hole, or because it has less metal to remove will give you a different finish which will require more tolerance for a press fit. The amount of metal in the hub or the thickness of the wall of the hub will also govern the amount of tolerance.

After wheels and axles are machined they are moved on conveyors to the mounting press. At the mounting press, wheels are placed on special dollies which hold them in vertical position and

axle is placed on an axle jack which can be raised or lowered to proper height to permit entry of wheels over journals. A mixture of whitelead and boiled linseed oil, which is checked periodically during the day with a Baume gauge, is applied to the wheel fits and protective collars are placed around journals. The wheels are then entered on axle, axle jack is lowered and the pair of wheels rolled into the mounting press. Wheels are mounted to the standard gauge, checked and rolled through the press down the ramp onto a dolly and moved to the storage tracks. Before the wheels are stored, the journals are coated with a journal preservative. If during the above operation, any of the wheels do not mount within the A.A.R. specifications of wheel and shop manual limits, they are marked misfit, returned to the demounting press for further handling. However, this is a rarity.

All journals to be trued on mounted axles progress from the unloading platform into the journal lathe, where they are trued and if the wheels are not to be turned they go on through the shop to be loaded or stored. All of the axles are magnetic particle tested in the above operations.

After wheels which require tread turning leave the journal lathe they are advanced to the wheel lathe where they are turned on collets or between centers. All wheels are turned as close as possible to the same diameter, but with never more than half tape size variation. The journals are then coated with a journal preservative and advanced to the storage track.

Inside and outside dial micrometers are used exclusively for measuring all wheel bores and axle wheel seat diameters. There are no hand calipers or rules used in this shop. (*The report here included recommendations for the inspection and maintenance of one type of roller bearings. It was presented by Chairman R. L. Frame, wheel shop foreman, New York Central, Beech Grove, Ind.*)

Discussion

One member stated that roller-bearing repairs, like wheel work, should be confined to one shop in so far as practicable where suitable equipment can be installed and due precautions taken to maintain high standards of cleanliness and keep dirt out of bearings.

A question was raised regarding the necessity of cleaning and Magnafluxing axles between wheel seats if no failures occur at that point without some mechanical abuse which is obvious on visual inspection. This question was not satisfactorily answered. The point was made that Magnaflux inspectors must be trained and shown what to look for, otherwise they may either become careless, or develop excessive imaginations which see condemning defects in "ghost lines" having no adverse effect on strength.

Another question related to possible hidden internal damage in the case of overheated journals which are subsequently turned down within A.A.R. limits and show no signs of defects. One member said that axles with discolored journals are discarded, but this is not common practice.

Members from several roads referred to failures of one-wear steel wheels due to shattered rims and the thought was expressed that when this happens the heat numbers should be given to shop forces for special inspection and change-out of these wheels. The question of economy in machining one-wear steel wheels was raised and no definite answer given.

Selection of Car Department Supervisors

What is a supervisor? Can we consider one definition to be—the link between top management and the daily and hourly-rated employees? Your committee feels that this definition is proper, that supervisors form the chain connecting top management with the employees, that supervisors are the links, main, or other, according to their position or capacity and that smooth, effiecient operation cannot be enjoyed if there is any weakness therein.

It is important in developing supervisors that they move step by step through the various channels of write-up man, gang foreman, etc., under the observation and tutelage of experienced supervisors, in which way serious and costly errors will not be made and in due time a qualified and confident general supervisor will be developed.

At the 1949 annual convention the Committee on Responsibility of Car Department Supervisors said that "A car department supervisor is charged with great responsibility. He is responsible for getting out production. He is responsible for the safety, health and physical condition of his subordinates. He is responsible for the development of morale or proper mental attitude in his subordinate group. He is responsible for cooperating with Management, fellow supervisors and his own subordinates. He is responsible for training and developing his subordinates. He is responsible for keeping records and making reports. In order to fulfill the above requirements, he must instruct, explain, interpret and enforce various rules, orders and requirements necessary for the proper operation in his department, do it intelligently and in a very unbiased manner."

These responsibilities should not be placed on the shoulders of untrained supervisors. It is not fair to them nor their employer. Such responsibilities can only be undertaken successfully when the supervisor had had opportunity, step by step, to develop under good leadership.

What are the qualities essential in a car department supervisor? Your committee hesitates to attempt to outline all of the qualities indispensable to good supervision but submit as a guide with no attempt to place in order of importance, the following items in which he should be well versed and training and selection should include these following six essentials:

Knowledge of Work—It is often said that success as a supervisor can be obtained without knowledge of the work supervised, if other qualities essential thereto are prevalent. While there are known instances where this has proven true, it is, nevertheless, inadvisable and unfair to the man. When such an attempt to develop a supervisor is made he must be given every opportunity to obtain sound counsel from an experienced supervisor if the effort to develop him properly is to be successful.

Enthusiasm—Genuine enthusiasm and the ability to arouse it in others results in interest, interest leads to knowledge and accomplishment. Enthusiasm along with knowledge of work form a great combination towards success.

Thoroughness—One of the most important qualities found consistent in the successful supervisor is thoroughness. It should be a habit. It is a necessity in all matters, especially in the small and unimportant things. Its absence has been the cause of failure of many supervisors. Delay, waste and time spent in correcting mistakes due to lack of thoroughness is needless expense. If the selectee's ordinary course of conduct is without the thoroughness management must use caution, must be sure that the selectee is of the type who can acquire it.

Fairness—An aid and foundation to lasting success is fairness. Its absence is the cause for many petty gripes and serious grievances. Nothing rests so bitterly inside any subordinate as unfair treatment from a supervisor. One of the greatest developers of morale is fairness. Along with the fairness we include impartiality and tactfulness. These qualities obtain loyalty, support and respect.

Intelligence—This quality must be present and considered at least to the extent required of the position. Consistent display of intelligence results in good judgment, a quality that leads to respect and admiration, all so helpful in creating and maintaining loyalty.

Health—Good health is one of the prime requisites to good supervision. It ties in generally with all the other qualities herein.

These qualities together with initiative, integrity, kindness and the ability to co-ordinate them in all decisions and action represent the fundamental qualifications for a car department supervisor.

The report was signed by Chairman R. E. Baker, assistant gen-

eral manager, B. & M., Boston, Mass.; K. H. Carpenter, superintendent car department, D. L. & W., Scranton, Pa.; H. S. Keppelman, superintendent car department, Reading Co., Reading, Pa.; J. E. Slaven, assistant superintendent, safety, C. B. & Q., Chicago; E. W. Gebhardt, assistant superintendent car department, C. & N. W., Chicago; R. G. Setzekorn, mechanical superintendent, American Refrigerator Transportation Co., St. Louis, Mo.; R. D. Bryan, mechanical assistant, A. T. & S. F., Chicago; C. L. Spees, Union Tank Car Co., Chicago; A. J. Larrick, regional master car builder, B. & O., Baltimore, Md.

Cleaning and Painting at Coach Yards

The cleaning and painting of passenger cars at railway terminals is frequently neglected or improperly performed. Furthermore, the procedures now practiced cause additional cost at a later date in the shop. Terminal work should be of value and can be if suitable care is exercised.

It appears, in some instances, that the cleaning and touch-up men have not been properly instructed as to just what is expected of them in the short period of time allotted. To cite a common example, vestibules, steps, platforms, trucks, etc., are painted over dirt, oil and grease. A practice of this sort becomes a waste of time and material since the part or parts painted fail to dry and the general appearance is not greatly improved over what it was before. Also to be considered are the damage claims which may result from this procedure. These can be lessened appreciably if the surface to be painted is properly cleaned and prepared before the application of touch-up paint. As mentioned above, the additional time and effort expended in the shop rectifying errors of this kind add needlessly to the cost.

Spot Painting Should Be Avoided When Possible

As further evidence of inadequate instruction, it is fairly common to have a painter, seeing an unsightly panel either on the interior or exterior of a car, repaint the panel without first preparing it for paint and with no thought for the consequences. Had the panel been adequately cleaned and prepared before attacking it with a paint brush, a presentable appearance for the car's next trip would have resulted instead of the botch that is so often seen. In any event, spot painting or touching up of spots should be avoided wherever possible.

In the interest of improving the touch-up paint systems employed, we recommend that a scrubber or cleaning man go over the cars, interior and exterior, ahead of the painter. Those areas in need of paint should be well-cleaned and, in the case of panels, sandpapered and, if necessary, glazed before painting. The touch-up material used by the painter should be of an accepted type to make resurfacing less difficult when the car goes to shop for general repairs.

If we are to best maintain the painted surfaces, we must take into consideration some of the factors which lead to paint deterioration, particularly on the exterior surfaces. This leads us into a discussion of cleaning methods. Regarding exterior washing or cleaning by manual or mechanical means, we shall discuss the hand operation first.

Here again, the efficiency desired is a matter of education. Often a cleaning or washing crew is left with improper or no supervision to carry out their duties. Being without sufficient instruction, they are left to their own devices relative to the cleaning operation. "Their own devices" usually evolves into an interest in cleaning the surface with as little expenditure of energy as possible and to this end cleaning compounds are added to their buckets to give cleaning solutions far beyond the safe concentrations for use. Some qualified person should be delegated to mix the cleaning solutions; this job should not be left to "just anybody" in the cleaning gang. Wherever possible, stock solutions should be made in quantity from which individual buckets can be drawn for use. This step alone could eliminate the possibility of paint damage due to overstrong cleaning solutions.

A cleaning crew should be instructed in the correct and systematic manner of going about the job. Elbow grease is necessary, but a lot of strength can be conserved by determining the approximate amount of effort needed to properly clean the equipment.

The practice of dipping the brush into dirt and cinders for abrasive assistance should be investigated, constantly checked, and eliminated. That this practice is used at several passenger car terminals is obvious from the number of scratched cars which can be seen.

More successful cleaning can be accomplished, regardless of the compound used, if the cardinal rule of all good cleaning procedure is followed in the washing of the vertical surfaces: *START FROM THE BOTTOM UP!* It is a well-known but little practiced rule and its neglect accounts for much of the streaked appearance of equipment due to the "setting" of soil in the paint film when cleaning solution (even plain water) is allowed to run down over a dry, dirty area.

Only approved concentrations of accepted cleaning compounds should be used with especial care being exercised that safe concentrations, as determined by the engineer of tests or the foreman in charge, are not exceeded.

Last in the steps to be followed, and most important, is the rinse. After an area has been cleaned, adequate rinsing will eliminate many of the difficulties encountered. Uneven appearance, considerable paint failure, and a great deal of corrosion can be avoided if more attention is paid to the rinsing operation.

Aside from the actual mechanics of washing, more consideration must be paid to the type of cleaning compound used, based on the type of finish on the car and the frequency with which the car is to be washed.

It is alarming how little attention is paid to these operations despite their seeming simplicity.

Mechanical washing machines are being installed by many railroads but in some instances they are not being operated to the best advantage. It is useless to expect any economy unless the machine is correctly operated to do the job for which it has been installed. Much of that which has been said about hand cleaning also applies to mechanical cleaning but, in the interest of consistency, we shall discuss them in their specific application to this method, the use of which is rapidly increasing.

There are two broad aspects to be considered; namely, chemical and mechanical.

One definite advantage of mechanical washing machines is that of storage of chemical solution. For the most part, cleaning solution is made up and stored in sufficient volume to justify more care in measuring the amounts of compound and water used, resulting in greater control of the concentrations.

One point which must be driven home is that frequently too much is expected of the washer. The mechanical washing machine does not and cannot be expected to do heavy cleaning in a single operation. Once the equipment is clean, a good job of maintaining cleanliness can be accomplished if the piece of equipment goes thru the machine on a regular schedule using a type and concentration of cleaning compound adjusted to meet the requirements of the particular railroad.

More attention must be paid to the choice of the cleaning compound used because there is a variety of conditions to be met. Obviously, the compound must clean. The type of soil to be removed varies with the kind of service encountered; whether the power is coal-fired or oil-fired steam, diesel-electric, motor car, trolley or third-rail electric must be taken into consideration. Also to be considered is the type of terrain through which the train travels, such as, mountainous with tunnels, desert, farm, industrial, etc. The design of the cars is another factor to be heeded; whether they are streamlined on conventional construction, head-end or coaches, etc.

Head-end equipment must receive special attention, either using stronger solutions of an acceptable cleaning compound

through the washing machine or the cars must be cleaned periodically by hand. This is necessary for two reasons; first, that the soil deposit is heavier toward the head-end of the train, and second, because these cars are switched for loading and unloading, they do not receive mechanical washing with the degree of regularity that other types of cars do.

More thorough examination must be made of the type of cleaning compound used pertaining to damage to equipment. Savings made in purchasing compounds on a price per pound basis effect no economy if efficient cleaning of soiled areas can be accomplished only by exceeding concentrations that will be safe for use. Attack on paint to the point where refinishing of the equipment becomes necessary, in less than the reasonably expected life of the paint, is distressing and costly. The cost of refinishing a car will pay for a considerable amount of a more expensive cleaning compound if the use of that cleaning compound extends the life of the paint. In choosing a cleaning compound for exterior washing, the type of finish to be cleaned and the frequency of washing are of prime importance.

Exterior Cleaning Compounds

The subject of exterior cleaning compounds is a highly controversial one as evidenced by the variety of cleaners being sold to the railroads by the chemical manufacturers for this purpose.

On certain types of finishes, relatively inexpensive, strong compounds can be used when the period of time between washings is long and the number of washings over the life of the finish is few. However, when washing is as frequent as it has become with mechanical washing of exteriors, it is of grave importance that mild cleaning compounds be used.

The maximum concentrations safe for use of any cleaning compound under consideration must be established either by the engineer of tests or on the basis of actual use data.

Among the considerations in the choice of a cleaning compound is not only the effect on the metals and paint of the cars but also the effect of the compound on the mechanical washer and its accessories. It is not feasible to provide storage and handling facilities made of special metals to offset the corrosive properties of the chemical compound nor is it possible to continually replace concrete areas that have been decomposed by these same chemicals.

The ideal cleaning compound would be one which would be readily and completely soluble in cold water to form solutions which would not dry out completely and which would have no deleterious effect on painted surfaces or on metals and alloys. It should remove both water-bound and oil-bound soil and carbon deposits. There are three reasons for wanting the non-drying property: One, that most chemical compounds used for this purpose are not active in a dry state; two, when moisture is retained lower concentrations can be used because chemical action continues; and, three, the retained moisture makes rinsing easier. Obviously, the compound should be free-rinsing so that no deposits will build up. Such built-up deposits form very concentrated chemical solutions when moisture from fog or rain is picked up enroute.

Where installation is possible and the conditions demand, it is preferable to have two solution storage tanks to take care of either light and heavy cleaning with the same compound or to allow for the use of two different compounds where the railroad prefers to use different cleaners for specific types of finishes.

In cases where the compound is not completely soluble in water it has been found that heavy deposits of undissolved materials in the storage tanks cause highly concentrated solutions to be sprayed on equipment when the volume of solution in the tank has been run low.

Car Washer Maintenance

Some of the mechanical aspects of mechanical washing include the efficient maintenance of the machine itself. Among these is the proper alignment of the revolving brushes in their relation to the vertical side of the car and the occasional adjustment of the tension of the brushes to compensate for the physical wear of the bristles. A simple gauge for this purpose which corresponds to the dimension between the inside of the rail and the exterior vertical side of the car as it passes thru the washer can be constructed of light lumber. One which has been made and successfully used was built as follows: From 1-in. by 2-in. stock, construct a cross-supported right angle with the vertical leg measuring the same as the height of the car and the horizontal leg measuring the same as the width of the car. Place a downward projecting stop-cleat on the horizontal leg to catch the inside of the rail toward the brush being adjusted so that the distance between the inside of the rail and the outer edge of the vertical leg corresponds to the distance between the inside of the rail and the exterior vertical side of the car. With this gauge in position, it becomes a simple matter to adjust the alignment and compression of the brushes to the recommendation of the washing machine manufacturer or to the proper adjustment for efficient operation as devised by the railroad even when the machine is not in actual operation or a car present on the track.

Considering economical and efficient operation of mechanical washers, it is suggested that the placement and delivery characteristics of the solution sprayheads be more carefully engineered. The number of sprayheads required, the degree fan thrown, the volume delivered per sprayhead, the degree of atomization and the pressure used will all be determined by the volume of cleaning solution required per car, the speed of travel of the car thru the washer, and the distance between the vertical side of the car and the standards on which the sprayheads are mounted. A balanced system is one in which the most efficient use of the cleaning solution is made by delivering complete coverage of the surface with a minimum of over-spray and a minimum of after-drip from the car.

Wherever possible, it is desirable that the sprayhead standards be portable to allow for changes of season. During cold weather, when soil deposits are generally heavier and there is a tendency for the cleaning solution to freeze on the cars, it then becomes possible to increase the concentration of solution and shorten the distance between the spray and the brushes. Conversely, during warm weather, solution concentrations can be decreased and the time for chemical action increased by extending the distance between the spray and the brushes.

In some installations, there is a heavy water rinse immediately before the brushes which rinses off the chemical solution previously sprayed on the car. The cleaning solution, therefore, receives no agitation and its effectiveness is reduced appreciably. Wherever possible, cutting down the volume of this preliminary rinse or even eliminating it and increasing the volume of water through the rinse after the brushes, is to be desired. If some water is required to reactivate the chemical solution enough to keep the brushes damp, it can be introduced directly into the brushes.

While we have dwelt primarily on the exterior cleaning of passenger cars because this is where the most flagrant damage has been done at terminal points, essentially the same principles of careful car cleaning procedure apply to the cleaning of interiors.

More Care on Interior Cleaning

Generally, more care has to be taken to do a finished job on the interiors of cars because color schemes and passenger appeal are involved. Since the recent trend of interior finishes has been toward lighter and brighter colors in the interest of public relations, complaints from the traveling public have increased tremendously from the apparently poor maintenance of these interiors. Soil on modern interior finishes, for the most part, is more obvious than in the past when the contrast between dirt and the color of the finish was not so great. Another factor involved in these complaints about interiors is the fact that the possenger has the entire trip in which to observe dirty conditions.

In addition, the advent of high speed schedules and the short lay-over times between departures have further complicated cleaning and painting procedures at terminals. When touch-up work is necessary, the use of quick-drying paints is made almost mandatory by the situation existing. The primary damage to interior paint appears at vestibules, body end doors, hallways, bulkheads and baggage racks and seems to be caused most by the hasty handling of luggage. Some railroads have offset this condition in part with combination cleaner-polishes that have a gloss com-

parable to the paint finish which enables them to spot clean with a damp cloth those areas where stains are still on the surface; such stains include also fingerprints elsewhere in the car.

In closing, the Committee on Cleaning and Paint Maintenance at Terminals is aware of the serious problems of metal corrosion with which the railroads are faced. It is our opinion that there are deeper aspects to this problem than the consideration of attack by cleaning compounds alone. For this reason we shall be interested in the progress being made by the various committees on corrosion that have been set up within the industry.

The report was signed by Chairman R. Middleton, painter foreman, N. Y. C. & St. L., Chicago; Vice-Chairman E. M. Driscoll, foreman painter, C. M. St. P. & P., Milwaukee, Wis.; H. E. Kneedler, painter foreman, C. & E. I., Danville, Ill.; W. J. Boltz, painter foreman, Pullman-Standard Car Mfg. Co., Chicago; D. Richmond, foreman painter, Pullman Company, Calumet Shops, Chicago; J. S. Pritchard, foreman painter, A. T. & S. F., Topeka, Kan.; J. Thomisser, painter foreman, C. R. I. & P., Chicago; J. M. Robertson, foreman painter, G. T. W., Port Huron, Mich.; L. A. Hartz, painter foreman, I. C., Chicago; B. T. Beck, master painter, G. N., St. Paul, Minn.; G. Cremens, painter foreman, C. & N. W., Chicago; R. Fisher, foreman painter, C. C. C. & St. L., Beech Grove, Ind.; B. Williams, foreman painter, A. T. & S. F., Topeka, Kan.; R. Barker, painter foreman, I. C., Centralia, Ill.; L. W. Lee, painter foreman, L. & N., Louisville, Ky.; C. O. Peterson, painter foreman, M. P., N. Little Rock, Ark.; W. Johnson, foreman painter, Pullman-Standard Car Mfg. Co., Michigan City, Ind.; F. Wohlen, foreman painter, C. B. & Q., Aurora, Ill.; K. C. Eade, Seco Mfg. Co., Chicago; L. A. Hoellen, E. I. Du Pont de Nemours & Co., Chicago; R. G. Mudge, Thresher Paint & Varnish Co., Chicago.

Discussion

A representative from the Southern Pacific referred to a joint terminal operated by three railroads in the west where the general foreman's ingenuity has provided a truck steam-cleaning spray just beyond the mechanical car washer. A good cleaning job is done on the trucks with steam at 150-lb. pressure after spraying on a heavy cleaner. A double washer is used at this point and the trains are pulled backward with the brushes retracted to give a double rinse as recommended by the committee.

One member referred to the deterioration of paint and corrosion of metal and was inclined to blame cleaner manufacturers, but this view was not generally upheld. The thought was stressed repeatedly that cleaning should be done only as frequently as necessary to keep equipment presentable and then use cleaners of minimum strength to cut the dirt.

A question was raised regarding the corrosion of stainless steel cars and the point was made that corrosion is not necessarily due to cleaner, but to the entrance of clear water under pressure to interior surfaces not properly sealed. Rust or electrolytic action of dissimilar metals then causes rapid deterioration of steel sheets and shapes.

The necessity of accurate control of cleaner strength was stressed. L. E. Grant, engineer of tests, C. M. St. P. & P., said that both acid and alkali type cleaners are apparently required, objection to the first being a tendency to attack painted surfaces and to the second being inability to cut oil and grease. He said that standard car washing machine brushes are not entirely satisfactory from a paint-wear standpoint and urged advance water spray to fill up crevices and exclude strong cleaner concentration from these places.

Interchange and Billing for Car Repairs

During the past year your committee has considered proposed revision of and additions to the present Code of A.A.R. Interchange Rules, and submits the following recommendations for submission, if approved by this body to the A.A.R. Mechanical Division:

Rule 9

Revise requirement opposite "Journal box lids, applied" as follows:

Proposed Form: Journal box lids applied (New or secondhand —Rule 101 item number, size and type designation number for AAR-1947 approved type lid.)

Reason: To simplify preparation of billing repair records.

Rule 9

Revise requirement opposite "Air brakes cleaned" as follows:

Proposed Form: Air brakes cleaned (R.&R. AB, *AB-1-B,* KD-4-12, K-1 or K-2, triple valve) (Name of road and date of last previous cleaning) (Work performed per Rule 60).

Reason: To harmonize with Rule 111.

Rule 16

In the case of cars stenciled by car owner "New Std. 1-W wrot steel wheels," recommend that handling line, when exercising its option and making an initial application of 1-W wrot steel wheels in place of cast iron wheels, be required to stencil car showing box location at which such wheels are applied. Therefore, suggest that Par. 4, Rule 16 be modified by addition of a new last sentence as follows:

Proposed Form: When effecting betterments or in application of new standards, a car owner may stencil car "NEW STD" (new standard) for any part of car (such as wheels, brake beams, etc.) while making partial change or without making any change. During the transition period handling line has the option of applying parts in kind or substituting the new standard. However, when such new standard details are removed account defective, they must be renewed in kind or with permissible substitutes. *When wrot steel wheels are applied, during the transition period, at one or more locations, car must be stenciled 1-W, 2-W, or M-W STL WHLS R&L—, for which a charge of one-half hour may be made.*

Reason: To protect car owner for application of wrot steel wheels applied during the transition period and to signify to subsequent repairing lines, when necessary to remove such wheels, that steel wheels are standard to car at the locations so stenciled.

Rule 17

Recommend revision of Note 9 following Par. (e) as follows:

Proposed Form: Note 9—Former A.A.R. Standard No. 15, A.A.R. No 3 or A.A.R. Standard No. 18 hanger type brake beams are permissible substitutes for hangerless type beams providing truck sides have brake hanger brackets cast integral therewith, except when the hangerless type beam removed is A.A.R. Standard No. 18, the hanger type beam substituted must be A.A.R. Standard No 18. *However, in cases of handling line responsibility defect card should be issued for labor and material.*

Reason: Hangerless type brake beams standard to car, when damaged in unfair usage, should be restored at expense of road responsible for the damage.

Rule 17—Sec. (1)

Recommend revision of this section as follows:

Proposed Form: (1) Extra heavy *pipe and* pipe fittings may be substituted for single weight type, or vice versa, as correct repairs, and charge based on type of fittings applied.

Reason: Due to continual increase in usage of extra heavy pipe and pipe fittings and because in many cases repairing line is unable to determine whether single weight or extra heavy pipe and fittings for hand rail on tank cars are standard, there should be no penalty where extra heavy pipe and fittings are applied in place of single weight in hand rails.

Rule 19

Add new Items as follows:

Proposed Form: 10-A. Secondhand journal bearings not complying with Section IV of the Lubrication Manual.

Reason: To comply and harmonize with requirements of Lubrication Manual.

Rule 66

Recommend addition to Paragraph (c) to read as follows:

Proposed Form: (c) The place, month, day and year of repacking and the railroad or private line reporting marks, must be stenciled on car body near the body bolster at diagonal corners with not less than 1-in. figures and letters, using the same station initial as is used for air-brake stencil. *If car is stenciled indicating car is equipped with approved packing retainer devices, such stencil must also be renewed.* This provision also applies to new cars.

Reason: To maintain this stencil on cars when initially applied by owner.

Rule 70—Par. (g)

Recommend modification of Par. (g) of this rule to read as follows:

Proposed Form: (g) Where one-wear wrought-steel wheels *or multiple-wear wrought-steel wheels* are applied by intermediate line on authority of defect card for cut journal in place of cast-iron wheels standard to car, in serviceable condition, bill shall be rendered against the car owner who shall render counterbill versus the road which issued defect card for the difference between the secondhand value of cast-iron wheels removed and the value *of multiple-wear steel wheels or* value of new, secondhand or turned one-wear wrought-steel wheels applied.

Reason: New Par. (g) was added to Rule 70, 1-1-50, in accordance with D. V. Circular 1186 and Docket No. A.C. 3602. The reason for this insertion is due to the fact that delivering line should assume the betterment cost not chargeable to the car owner where the repairing line was obliged to apply one-wear wrought-steel wheels in place of cast iron on authority of defect card issued by the delivering road. The type of wheels standard to the car are not always available and it is felt the same condition should be extended to include the liability of the delivering line when multiple-wear wheels are applied under similar conditions. This would also conform with the rulings handed down by the Secretary, November 20, 1947, under Docket A.C. 3498.

Rule 70—Interpretation (1)

Recommend modification of Inter. (1) of this rule to read as follows:

Proposed Form: Interpretation. (1) Q.—What charges shall be made in case wrought-steel wheels are removed and same kind applied to a car not stenciled for type of wheels standard to it?

A.—In such case cast-iron wheels shall be considered as standard to car. Therefore charge for wrought-steel wheels applied shall not exceed A.A.R. prices of new cast-iron wheels for owner's defects, or secondhand cast-iron wheels for handling line defects.

Reason: The last portion of the answer to Interpretation (1) of Rule 70 should be eliminated as same is in direct confliction with Section D and Section F of Rule 70 and Joint Evidence should not be required to establish a fact that is known by both the repairing road and the owner. Joint Evidence is a means of establishing improper repairs whereas the repairs as provided in the above is not considered improper repairs in accordance with Section A of Rule 70.

Rule 88

Recommend elimination of Par. 4 of this rule covering the use of wood draft timbers in place of metal draft arms as this construction is now obsolete.

Rule 91—Inter. (5)

Recommend revision of Inter. (5) to read as follows:

Proposed Form: (5) Q.—Referring to Sec. (c) in connection with other errors or questionable charges, does this same time limit apply to duplicate charges?

A.—*An additional time limit of 90 days (or a total of 270 days) from date original bill is passed for payment may reasonably be allowed* for adjustments required on basis of Sec. (h) and (i) of Rule 60, *Par. (g-3)* and *Inter. 2 of Rule 66,* Rule 81, Rule 90, Par. (b-8) and (c-3) of Rule 98 and Inter. 8 of same rule, and Rule 99, provided such exceptions are definitely subject to the provisions enumerated herein. This time limit applies to the last bill thus involved.

The cases enumerated above are also subject to Inter. 3 under this rule.

Reason: In some cases wrong car numbers on repair cards are not corrected to give sufficient time to place cards in file and check against other roads' repair cards and make claims within time limit now allowed.

Rule 101—Items 46 and 47

Modify Notes following Items 46 and 47 to read as follows:

Proposed Form: Note.—Where service portion *is* damaged by fire and renewed complete on authority of defect card, charge may be made for 55 per cent of price new shown above. However, to justify such charge, air brakes must be given complete periodic attention at the same time, as outlined in Rule 60, for which additional charge is proper.

Proposed Form: Note.—Where emergency portion *is* damaged by fire and renewed complete on authority of defect card, charge may be made for 55 per cent of price new shown above. However, to justify such charge, air brakes must be given complete periodic attention at the same time, as outlined in Rule 60, for which additional charge is proper.

Reason: To clarify intent that defect card must show portion or portions of AB valve damaged by fire.

Rule 101—Item 115-A

Recommend elimination of Item 115-A reading as follows: *"115-A. Chain, brake beam safety, ordinary or special design, per lb. . . . $0.155 $0.005"* because this construction is now obsolete.

Rule 107—Item 15

Recommend revision of this item which provides for renewal of hangerless type brake beam, to read as follows:

Proposed Form: 15. Brake beam, hangerless type, renewed, when not in connection with R&R. or R. of truck bolsters, one or two truck sides of any type, or wheels in trucks with cast-steel truck sides having integral journal boxes..... ..(-)

Note.—When renewed in connection with R&R. or R. of truck bolsters, one or two truck sides of any type, or wheels in trucks with cast-steel truck sides having integral journal boxes, charge as per Item 14. .....

Reason: An average allowance should be specified to avoid the variance in charges now rendered on an actual time basis.

Passenger Car Rule 19

Recommend that provisions incorporated in the last three paragraphs, which define manner of billing repairs on cars of freight car construction equipped with passenger car trucks and on cars equipped for passenger train service having freight car trucks, be modified as shown in the proposed form below.

Reason: To clarify intent of Rule 19 and eliminate confusion and misunderstanding in pricing repairs made to this type of equipment.

PROPOSED FORM

Kind of Trucks	Body Construction	Service	Manner of Billing For Repairs
Passenger	Freight	Irrespective	Truck Repairs—Pass. Rules Body Repairs —Freight Car Rules
Freight	Passenger	Passenger	Truck Repairs—Freight Car Rules Body Repairs —Pass. Car Rules

P.C. Rule 22—Items 3-A and 3-B

Recommend new Note be added following Item 3-B of Rule to read as follows:

Proposed Form: Note.—The above prices for bulbs do not apply where necessary to R.&R. shades to renew bulbs. In such cases charge, shall be on basis of Storehouse cost for material, plus actual labor of application.

Reason: To clarify intent allowances specified in Items 3-A and 3-B apply only to the ordinary type electric bulb and that charge for other bulbs which require R&R of shades or other receptacle, charge shall be rendered on actual labor and material basis.

The report was signed by Chairman R. W. Hollon, mechanical inspector, A.A.R. billing department, C. B. & Q., Chicago; Vice-Chairman R. W. Parker, superintendent railway equipment, Tennessee Copper Corp., Copper Hill, Tenn.; M. E. Fitzgerald, retired, assistant to superintendent motive power, C. & E. I., Danville, Ill.; C. W. Kimball, assistant supervisor car inspection, Southern, Atlanta, Ga.; F. J. Larrisey, chief A.A.R. inspector, Erie, Cleveland, Ohio; Frank McElroy, assistant to vice-president, Union Tank Car Co., Chicago; J. J. Sheehan, supervisor car repair bills, M. P., St. Louis, Mo.; Fred Peronto, secretary, Mechanical Division, Association of American Railroads, Chicago; C. R. Wiegmann, chief interchange inspector, St. Louis Interchange Bureau, E. St. Louis, Ill.; H. Belond, A.A.R. inspector, C. M. St. P. & P., Milwaukee, Wis.; J. E. Walsh, superintendent, St. Louis Refrigerator Car Co., St. Louis, Mo., F. Jude, chief A.A.R. billing inspector, C. N. Montreal, Quebec, Can.; L. L. Pierce, supervisor, A.A.R. department, General American Transportation Corp., E. Chicago, Ind.

Discussion

In response to a question Chairman Hollon said there is no move at present to reduce the condemning limits on chilled iron wheels out of round or with worn treads, but this subject will be continued for a report next year.

P. B. Rogers, shop superintendent, Santa Fe, asked for a rule preventing the substitution of multiple-wear wheels, turned down, in place of one-wear wheels as this often makes refrigerator car fans inoperative.

A representative of the Northern Pacific said this is a good point as regards 33-in. multiple-wear wheels, but some 36-in. multiple-wear wheels would operate the fans OK after turning.

Minor changes were suggested in Rules 9 and 16 but were voted down. Regarding Rule 70, Par. (g) it was recommended that the rule be modified to include slid-flat wheels as well as cut journals. This motion was carried.

It was moved to re-instate the last sentence in Rule 70, Inter. 1 but this action, when put to a vote, failed to carry.

(The report was accepted and recommendations as modified, ordered referred to the A.A.R. Mechanical Division.)

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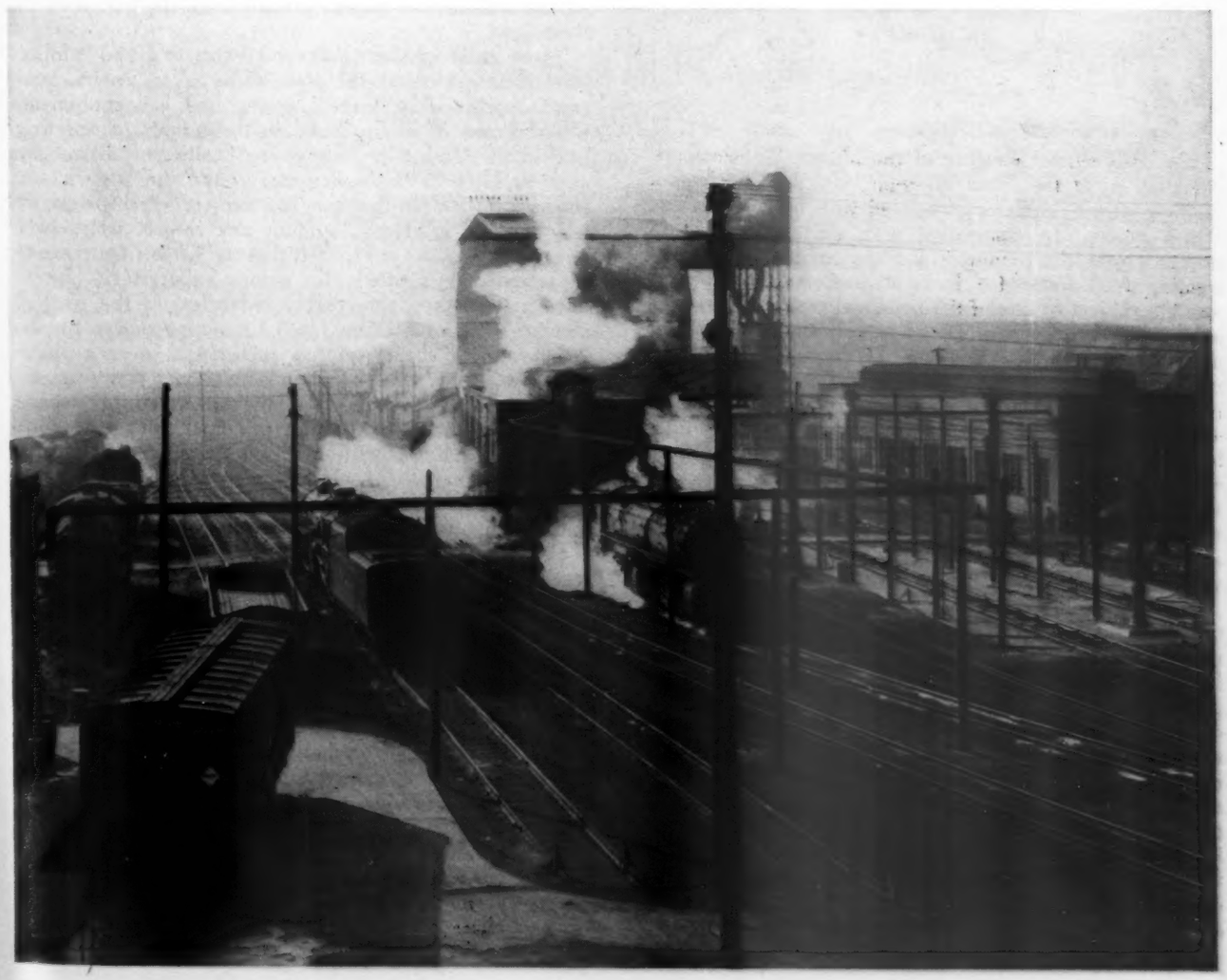


Boiler Problems Discussed

This year's reports cover steam and Diesel problems and the factors involved in heating passenger trains

E. H. Gilley
President
(General boiler foreman, G. T. W.)

THE 33rd annual meeting of the Master Boilermakers' Association, at the Hotel Sherman, Chicago, September 18-20, covered problems associated with both steam and Diesel power. In connection with the latter form of motive power the economic and the technical details of treating feed water for locomotive steam heat boilers was the subject of one of the principal reports. A second subject which concerned Diesel power, and steam power as well, was the determination of steam heat requirements for passenger trains. Steam locomotive topics included the advantages of steam space spray boiler checks, proper brick settings for oil and coal burning locomotives, the use of special coatings for the interiors of boilers and tenders as well as the exterior of flues and tubes, the conditioning of boiler and firebox sheets after heavy classified repairs, preparing locomotives for storage and removing from storage, and procedures for seal welding staybolts.

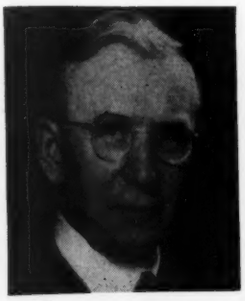
President Gilley's opening address called attention to the fact that while many roads were increasing the number of Diesel locomotives, one road is presently building steam power and a number of roads are returning steam locomotives to service to meet the increased demand for motive power. He stressed the importance of the meeting, saying that the members were present for the purpose of educating and better fitting themselves for the operation and maintenance of steam locomotives and that these purposes can best be accomplished by attending all sessions and entering into the discussion. In this way each member can absorb the best ideas advanced by others and will contribute freely of the best of his own experiences.

Secretary Stiglmeier spoke on the advantages of associations and conventions. He recalled that as far back as history records and presumably before that, primitive as well as civilized people have convened to exchange ideas, to create states, to formulate religious creeds, to foster education and science, to promote human welfare and progress, and sometimes, he admitted, to destroy established orders. On the whole, he noted that associations and their meetings are constructive, and have resulted in the betterment of work on railroads. Conventions today, he continued, are necessary to preserve order and to agree on codes of practice so that adequate foundations can be established for the future. He stated that some proposals advanced at meetings have proven to be of inestimable value, and that any which seem right when proposed but later found wanting are discarded. He called attention to the privilege of listening to committee reports and special papers prepared by the best men in their field.

Three guest speakers delivered interesting and informative messages before the association. W. C. Bowra, general superintendent motive power and car equipment, Grand Trunk Western, spoke on the subject of selecting individuals for senior supervisory positions, particularly as it pertains to the boiler maker and the boilermaker supervisor. He felt that this is a subject which primarily concerns the individual without any respect whatsoever to craft classification. He felt that the basic requirements in selecting individuals for senior supervisory officers have not changed appreciably regardless of the marked changes that have taken place in motive power trends. As the senior supervisor has jurisdiction over a multiplicity of work and operation involving many or all crafts, a broad general knowledge of mechanical department work is essential. Other principal things to which Mr. Bowra felt recognition would be given in selecting supervisors are the necessary personality, energy and honesty, industriousness and the qualities of leadership and organizational ability for shouldering responsibilities.

C. E. Bell, superintendent of safety, Reading, briefly traced the history of the locomotive boiler inspection act and its constructive results. He said that railroad men recognized the need for a similar set of rules and regulation to govern their work methods in order to prevent personal accidents. He answered the question of what the boilermaker can do to improve safety by outlining the program followed by the Reading.

E. H. Davidson, director, Bureau of Locomotive Inspection, Interstate Commerce Commission, paid tribute to the early boilermakers, who he said were furnished only a boiler outline and some limiting dimensions and were expected to build a boiler from the ground up, and some of these early boilers gave satisfactory service for a half century or more. He noted that many difficulties which render boilers less efficient for service seem to be more or less epidemic in nature and often effect a number of



R. W. Barrett
Vice-Pres.
(Chief boiler inspector, Central Region, Can. Natl.)

A. F. Stiglmeier
Sec.-Treas.
(General supervisor boilers and welding, N. Y. C. System)

boilers of identical design and construction after an equivalent amount of service. He cautioned against continuing flues in service longer than their physical condition warrants, and said that accidents from burst or broken flues still occur at too frequent intervals. Repairs to one defect occasionally set up a condition that results in an accident from another cause. As one example, making a repair in which three superheater units were removed and the header opening blanked, decreased the resistance to flow of the products of combustion through the flues involved and the increased flow of cinders resulted in excessively rapid metal wear on one flue which failed from cinder cutting, seriously injuring one member of an engine crew. He emphasized that few accidents just happen but are a result of a defective condition, which, if recognized and corrected, would have prevented the accident.

Election of Officers

Officers and Board members were elected to serve for the coming year: President, R. W. Barrett, chief boiler inspector, Canadian National; Vice President, H. C. Haviland, supervisor of boilers, New York Central, Lines East; Secretary-Treasurer, A. F. Stiglmeier, general supervisor, boilers and welding, New York Central.

Executive Board: Chairman, H. C. Haviland; Secretary, H. R. Barclay, general boiler inspector, Northern Pacific; C. G. Wollard, general boiler and welding foreman, Chicago & North Western; F. R. Milligan, general boiler inspector, Canadian Pacific; F. E. Godwin, mechanical inspector, Canadian National.

Additions to the Advisory Board: F. Benger, assistant chief of motive power and rolling stock, Canadian Pacific; H. Hill, superintendent motive power and rolling equipment, Reading; A. G. Hoppe, engineer of research and development, Chicago, Milwaukee, St. Paul & Pacific; J. E. McLeod, superintendent motive power, Chesapeake & Ohio; and F. O. Young, mechanical engineer, Northern Pacific.

Steam Heat Requirements on Passenger Equipment

Several years ago road tests were conducted with standard steel coaches to determine the value of insulated connections and the amount of steam required to heat a passenger car in sub-zero temperatures. It was found that the average steel coach equipped with double sash windows would utilize approximately 250 lb. per hr. However, the inside temperatures of the cars would gradually decrease while the train was in motion, indicating insufficient radiating surface within the car to maintain proper room temperature. This condition was true of the head end cars where ample steam and pressure were available.

Changes in car construction in the past few years have included the use of better insulation, fin-type radiation and overhead heating. All of these add up to better heating but the steam demand per car is still approximately 300 lb. per hr. for good heating in cold weather.

An investigation resolved itself into two parts, the first dealing with the locomotive and the second with the equipment to be heated. Rather than employ the use of a large number of cars to establish the various rates of steam flow, we devised a simple orifice device to simulate the demand of a varying number of cars which could be used for tests with both the locomotives and the cars. The flows were computed by the use of Grashof's Formula for steam flow. Its accuracy was checked by condensing the steam at different rates and found to be reliable. Having established the steam consumption per car to be 300 lb. per hr., it was an easy matter to establish the steam flow necessary to heat any number of cars.

It was of first importance to determine the characteristics of the steam heat arrangements on the various types of passenger locomotives so we would know the steam available at the source. The investigation covered locomotives equipped with 2-in. and 2½-in. steam heat piping as well as an arrangement where tender piping was 2½ in. and the locomotive 2 in. The determinations were made on steam and electric locomotives only, as no Diesel passenger locomotives were then in service.

Regardless of the sufficiency of steam supply, the pressure at the rear of the locomotive is the factor that determines the maximum amount of steam that can be utilized for train heating. This pressure must be sufficient to overcome the pressure drop through the train line, end valves, connectors and the drop in pressure due to the steam consumed by each car for heating. In addition, sufficient pressure must be available at the rear of the train to assure good operation of the heating system of the rear cars. It is, therefore, imperative that there must be a minimum of pressure drop from the boiler to the rear of the tender. The lower the working pressure of the boiler, the more important becomes this pressure differential.

Pressure Drop vs. Pipe Size

At a steam flow of 5,500 lb. per hr. (approximately a 17-car train), there was a loss of 41 lb. per sq. in. between the boiler and the rear of the tender with 2 in. piping. A change to a 2½ in. piping system resulted in a drop between the same points of 22 lb. per sq. in. or a reduction of 46 per cent in pressure loss. This saving of 19 lb. per sq. in. could be used to heat one or two more cars. The same situation is evident on the electric locomotive where the reduction in pressure loss was 59 per cent. Such an improvement was sufficient to specify 2½-in. steam heat piping systems on the present Diesel passenger locomotives. In the case of the steam locomotives approximately 70 per cent of the pressure drop occurs in the pressure regulating valve and the steam connections between the engine and tender. This situation is true regardless of the size of pipe used. Pipe fittings themselves, particularly right angle elbows contribute heavily to the pressure losses and the elimination of all possible bends will be of further improvement.

The drop in pressure through a train is recognized as being a function of the steam flowing, the specific volume of the steam, the size and length of the pipe and fittings, the car heating demand and the incidental losses. The magnitude of the pressure drop through any specific car will, therefore, depend upon these factors, as well as the position of the car in the train.

Testing Methods Employed

The method used to determine the pressure drop through the passenger equipment was somewhat novel. Two passenger cars

with similar heating equipment were used and coupled to a steam locomotive, with the 2½-in. steam heat equipment. Pressure drops were determined through the end valves, car connectors and train line for various rates of flow. Car bleedoff was maintained at 300 lb. per hr. From these determinations it was possible to establish the number of cars that could be heated with a given pressure at the rear of the locomotive or the pressure required to heat a given number of cars.

This method of testing, whereby trains of varying length are simulated, is accomplished by the use of calibrated orifices in conjunction with pressure readings and control of steam flow by means of valves. The flow of steam through the train line was measured and controlled with the same apparatus as was used to determine the values on the locomotive. This apparatus was connected to the steam heat connector at the rear of the second car. The actual car heating systems were shut off and a bleedoff orifice attached to the train line at the point where the steam enters the heating system.

Pressure drops were obtained for rates of steam flow from 1,000 to 8,000 lb. per hr. with initial pressures varying from 25 to 230 lb. per sq. in. The pressures at the rear of the tender were controlled by a regulating valve in the cab of the locomotive. Tests were conducted with passenger equipment having 2-in. and 2½-in. train lines in conjunction with various arrangements of connectors and end valves.

The results show the relation of the hourly steam flow in relation to the pressure required at the rear of the locomotive. While curves can be developed for any pressure at the rear car, we have selected 20 lb. per sq. in. as representing a satisfactory pressure to heat an air conditioned car. Similar to the design of a large building where you design from the roof to the foundation, you develop the pressure curves from the rear of the train to the locomotive.

The Value of 2½-in. Piping

A 15-car train comprising 2-in. equipment requires a pressure at the rear of the locomotive of 190 lb. per sq. in. while the 2½-in. equipment requires only 112 lb., a difference of 78 lb., or 41 per cent. This difference is important when you consider that few locomotives have much more than 200 lb. per sq. in. available at the rear of the locomotive. A 25-lb. drop at the boiler would reflect directly in the train line with the result that the rear cars will be starved for steam. Once the rear cars freeze the return of boiler pressure does not thaw the equipment.

The greatest pressure loss in car equipment lies in the end valves and connectors. At a flow rate of 5,500 lb. per hr. through a car equipped with a 2-in. train line, end valves and connectors, the pressure drop will be in the region of 27 lb. of which 12 lb. is through the train line and 15 lb. through the connectors and end valves. The application of 2½-in. connectors and end valves to the same train line will reduce the pressure drop to 17 lb., a reduction of 10 lb. or 37 per cent. Here is where the 2½-in. equipment shows the best advantage and is readily accessible for change.

The report was prepared by K. D. Relyea, dynamometer engineer, New York Central.

Treatment of Feedwater for Locomotive Steam Heat Boilers

Internal Treatment is where the chemicals are added to the raw water and the chemical reactions between the hardness of the raw water and the chemicals takes place entirely within the boiler. External Treatment is the term applied when all or the greater part of the softening reactions are completed outside the boiler and only finished water is added to the boiler.

Internal treatment was first recommended for Diesel locomotive steam generators but soon it was proven that the reserve treatment normally carried within the boiler waters of steam locomotives was not sufficient and, therefore, the amount of reserve treatment was increased. This resulted in faster precipitation of the hardness salts of the raw waters as well as better conditioning of the sludge formed, eliminating to a great extent the scaling of the coils and the plugging of the auxiliary pipe lines and controls. Satisfactory results were obtained with this treatment as long as the raw waters used were not more than medium hardness.

Potassium carbonate in place of sodium carbonate (soda ash) was tried as it more rapidly precipitates the hardness salts of the raw water at lower temperature. With this treatment, excellent results were obtained with less reserve treatment than originally required with sodium carbonate. Also, waters with hardness of over 20 grains per gal. was successfully conditioned. The sludge formed by reactions between potassium carbonate and scale-forming minerals had the property of less stickiness than that formed by reactions with sodium carbonate; therefore, greater freedom from incrustation troubles were had.

The limited space within these locomotives has been the greatest handicap in selecting suitable chemical proportioning equipment for feeding the chemical to the water just before it enters the boiler. The first feeders supplied with each unit proved unsatisfactory. Modification of these feeders on at least one railroad had given good results. Numerous other feeding equipments have been tried with varying results.

The best method for feeding this form of treatment is to proportion the chemical to the feedwater before delivery to the water storage tanks of the locomotives, the same as the arrangment frequently used for steam locomotive feedwater. However, this arrangement would entail housed equipment and wayside water storage tanks at sufficient elevation, or booster pumps to supply the treated water at the required flow, to fill the locomotive storage tanks within the allotted time. In most instances, considerable underground piping would also be required to convey the treated water to several outlets. The estimated costs for this proposal have restricted the selection of this method in a number of cases. With the internal treatment, blowdown of the boiler is required to reduce sludge and soluble salt accumulation.

External Treatment

There are three general methods for external treatment. Demineralization removes all mineral salts except silica. Thus sludge and dissolved solids build-up within the boiler is nil, which is ideal for its operation. However, degasification and suitable auxiliary treatment of the water is required to prevent pitting and corrosion. Equipment comprises tanks, water meter, piping and valves. The first tanks through which the water passes contain synthetic resins having the ability of completely removing the ions from the raw water. In the Cation exchanger, all of the positive ions such as calcium, magnesium and sodium are removed, while in the Anion exchanger, all of the negative ions are removed with the exception of carbon dioxide. A degasifier, removes the carbon dioxide. Auxiliary treatment for corrosion control is proportionally fed to the effluent before flowing to storage or use. Other containers or tanks are used to hold the acid and alkali for regenerating the Cation and Anion exchangers, respectively.

The Zeolite method entails about the same principles as the Demineralization method. The first tank through which the raw water flows contains the Zeolite material which has the property of exchanging its sodium content for the calcium and magnesium ions of the raw water. The effluent thus contains the equivalent in sodium salts which do not form scale under normal concentration. However, the exchange is never quite complete and a very small amount of residual hardness remains which will form scale or sludge. A brine solution is used to regenerate the Zeolite material. This method requires auxiliary treatment for conditioning the residual hardness and to prevent pitting and corrosion. Blowdown is needed to control soluble salt concentration.

Lime soda ash equipment is usually comprised of a large settling tank having a downcomer of about one third its diameter installed within its center, chemical solution tanks, chemical proportioning equipment, pumps and piping. Housing for the solution tanks and equipment are required, and about one-half grain per gallon of residual hardness usually is contained within the effluent. Auxiliary treatment for conditioning the residual hardness and for pitting and corrosion control is usually required, as is blowdown of boilers for sludge removal and soluble salt concentration control.

The initial cost of equipment and its installation have, to a large extent, restricted the selection of the above methods. Where the quality and quantity of the raw water would justify the expense, they should receive consideration.

Treated Water Saves Fuel

At the 1948 Annual Meeting of the Railway Fuel and Traveling Engineers' Association, it was reported that a severely scaled Clarkson type steam generator wasted up to 29 per cent of the fuel used for steam generation. With a unit fuel cost of $.09 per gallon, this represents a fuel loss of $2.45 per 1,000 gal. of feed water used. Thus, it is apparent that water conditioning can be economically justified without taking into consideration reduced maintenance expense or more satisfactory performance in revenue service.

Corrosion shortens the life of outside coils to about one year and the inner coils to about three years. It is believed that this corrosion is primarily due to oxidation. However, acid washing used to clean these coils may also be responsible, especially if the acid is not thoroughly washed out or neutralized. For those experiencing serious oxygen corrosion, it would be well to consider the use of a steam deaerator incorporated in the flow cycle of the water to the steam generator. There is now available a deaerator of such size that it can be installed on steam generators on most Diesel locomotives.

The members of the committee were T. W. Hislop (chairman), water service engineer, New York Central; S. H. Christopherson (vice-chairman), supervisor of boiler inspection and maintenance, New York, New Haven & Hartford; F. K. Jones, chief engineer, Dearborn Chemical Company; J. C. Hutton, vice-president, The Bird-Archer Company; R. W. Seniff, engineer of tests, Baltimore & Ohio; E. M. Miller, service engineer, National Aluminate Corporation; R. S. Glynn, assistant engineer of tests, Atchison, Topeka & Santa Fe; R. E. Coughlan, engineer of tests, Chicago & North Western.

Discussion

A member from the G. M. & O. reported that even with half treating the water at times the coil life was less than 9 months and water pressures would rise to 600 lb. with the 10-day acid washing schedule. Water treatment has answered the problem so that now high-water pressure is practically unknown and coil life is generally good, many coils lasting 3 and 4 years.

Secretary Stiglmeier asked if the use of air pressure of perhaps 25 lb. over boiler pressure for forcing the water in the boiler would add enough oxygen to that water to create corrosion and pitting. The answer was that the solubility of oxygen in water is a function of the partial pressure and of the temperature of the water so that anything that increases the partial pressure, such as air pressure, would intend to increase the solubility of oxygen. The solubility of oxygen and water at 212 deg. with no pressure becomes zero. Therefore air pressure on top of the water would create corrosion and pitting. This was confirmed by experience on three boilers. Two were pump fed while the third was fed by air forcing the water into the boiler out of a tank. The two pump fed boilers showed no pitting.

E. D. Hall, engineer of tests and chief chemist, Erie, planned on giving steam generators nothing but demineralized water and on the demineralizers, instead of having a 2-bend system and using a deaerator to remove carbon dioxide, played extra safe and put in a 4-bend system without deaerators. This was highly successful as long as water was taken only from these plants. No coils plugged up, no high water pressures occurred, and no scale was found inside on any tube. Instead, corrosion of the entering and outlet bends for the first 8 to 10 in. was found, and only a year's service could be obtained from the outside coil. The corrosion seems to be right at the point where the water comes in, makes the bend and turns. Examination indicated that the trouble was not so much corrosion as it was erosion. Perhaps a special coating on the inside of the coils at the bend area will help to withstand the erosion. He felt that water should be treated no matter how soft it was.

Preparation of Locomotives for Storage and Removal from Storage

Two general methods are used to prevent corrosion in stored boilers, the wet and the dry methods. While the wet method is somewhat easier to use, it cannot be used where the boiler is subject to freezing temperatures. The following procedure is used for the dry method:

A.—Drain boiler.

B.—Dry thoroughly, including all parts where pockets of water might be trapped. A light wood fire or circulated air may be used for this purpose.

C.—Place quickline (not hydrated lime) in suitable flat containers in the boiler. The trays should be on supports so that they do not set flat on the boiler surface. The amount of lime should be about 20 lb. per 100 hp. boiler capacity, or 7 lb. per 1,000 lb. per hr. boiler capacity.

D.—Seal all openings through which air or steam might enter.

E.—Open boiler and inspect every two months, taking care to reseal thoroughly immediately after inspection. The lime should be renewed if found to be wet.

Before being stored the boiler and tender should be washed out. To insure removal of all water and moisture from the boiler and the superheater units, open the throttle sufficiently to allow steam to work through units and when the steam has been used up, allow boiler to cool down. Removing washout plugs above water line will facilitate cooling process. Drain the boiler when reasonably cool. Heat remaining in the boiler will dry up any residue moisture.

Drain valves or plugs on all air or steam operated auxiliary equipment should be removed or left open. Disconnect any boiler head gauge syphons to allow same to drain. If a McAvity-type tender water level indicator is used, the mercury should be drained and collected for re-use.

The tender should be completely drained, jacking up the rear end if necessary. Where oil skimmers are used care should be taken to see that compartments are drained and clean. The firebox should be cleaned out, the brick arch removed, undamaged brick salvaged, and flues and tubes blown. If no method has been used that prevent the accumulation of ash and cinders behind grate carrier bars, this area should be cleaned out. The ashpan should be washed down and dumped.

The area below and on the table plates in the smoke box and the netting should be cleaned out. If there is a plug located in bottom of smoke box it is advisable to remove same.

Coal should be removed from the tender, and the bunker plate surfaces given a coat of corrosion resistant paint. Whether washout plugs around foundation ring should be removed or not is a matter of opinion. If left out plugs should be carefully stored in cab seat boxes, and the plug hole threads given a coat of graphite.

A wooden cover should be fitted over smoke stack rather than canvas. When engines are stored outside where it is not possible to keep a close watch, the windows and headlight should be boarded up. All loose equipment in the cab needs to be taken

off, such as pokers, slice bars, oil cans, scoops, lanterns, surplus hard grease, etc., and if the locomotives are to be stored permanently, all brass parts such as whistles, lubricators, safety valves, gauges, etc., should be removed in case of theft. Doors and windows should be secured on the inside and on nonvestibule cabs the back of the cab should be boarded up.

For outside storage all bright or finished metal parts should be given a coat of grease. It is good practice when storage follows shopping to give boiler and firebox jacket and exterior tender plates a good coating of grease or rust preventative. A regular check should be made so that any damage or corrosive action may be noted at once and steps taken to prevent further damage.

When a locomotive is being prepared for return to service, or when received dead from another station during cold sub-zero weather, the locomotive must be placed in the roundhouse or other heated building and allowed to gradually thaw out until the back of the hand can be held comfortably on any part of the boiler before it is filled up with water. Firing up should be done slowly to avoid undue stresses being set up on the boiler by sudden change in temperature.

The committee members were R. W. Barrett (chairman), chief boiler inspector, Canadian National; T. J. Lyon (vice-chairman), superintendent of equipment, New York Central; H. W. Chandler, Interstate Commerce Commission locomotive inspector, Bureau of Locomotive Inspection; H. S. Love, boiler inspector, Reading; H. E. May, shop engineer, Illinois Central; P. K. Ingle, locomotive inspector, Board of Transport Commissioners for Canada; M. R. Foxx, general boiler foreman, Cleveland, Cincinnati, Chicago & St. Louis; C. Zaske, traveling boiler inspector, Southern Pacific.

Coating the Interior of Boilers and Tenders

When railroads realized that in order to improve the overall efficiency of the locomotive it was necessary to have clean boilers and improved boiler feed water, energetic campaigns of boiler washing and boiler feed waater treatment were entered into. Shortly after this, increased pitting took place to boiler sheets and was attributed to the cleaner sheets not being protected by a film of scale. Further improvement in the treatment of water reduced this amount of pitting or corrosion appreciably, but certain types remained.

To rid the boilers of the remaining cases of pitting, several methods were tried out under service conditions, and coating the interior surfaces of boiler sheets and exterior surfaces of tubes and flues appeared to be the most successful. Many roads using this practice report no additional cases of pitting or corrosion where the coating was applied to new sheets and no extension of defects where it had been applied to old sheets that had nominal pitting before the coating was applied. They also report a decided decrease in the amount and thickness of scale adhering to the sheets, and that the labor of removing this scale was reduced at least 50 per cent due to the scale formation not being bonded as tightly to the coating material as to bare metal.

It became evident that if some suitable type of coating were found that could be successfully applied to the cistern sheets, a saving in both labor and material would result. The extent and frequency of tender repairs soon caused those responsible for tender maintenance to experiment with painting the coal pit sheets and under side of tender bottom and later on the interior of water cistern with various types of paint, mostly those having a lead base. While this protected to some extent the coal pit sheets and underside of tender bottom, it was soon realized that coating the interior surfaces of tender cisterns with this type of material was impractical as a satisfactory bond to the metal was not obtained and the paint material soon loosened itself from the plates. This material found its way into the boiler and the substance, of which it was composed, created a very detrimental condition which demanded that the practice be immediately stopped. The painting of tender bottoms and coal space sheets was continued and applied at each shopping period. While producing some beneficial results, it could not be said that it was satisfactory to any great degree as the renewal of these sheets was necessary at too frequent intervals.

In due course of time several materials were brought forth that proved satisfactory to a very marked degree. Today exact knowledge is had of a large number of tenders in service ranging from 15 to 20 years that received coatings to the interior and exterior surfaces of tender cistern sheets which have almost entirely eliminated the need for repairs in this length of time. These are continuing in service with the original coating applied to the water space sheets and with a second and third coating applied to the coal space sheets. The interior of these tenders and others with similar coating applied at a later date show no evidence of pitting or corrosion and none of the material has become loosened from the plates. The substance of this material to date has not been charged with producing any unfavorable condition within the boiler.

Requirements for Boiler Coatings

Since the conditions of service in the boiler are so distinct from those in the tender it follows that the requirements to be met by a coating suitable for the boiler are equally distinct from the requirements for a coating in the tender. A protective coating on the water and steam exposed metal in the interior of locomotive boilers must have a high flash point; be non-toxic; be suitable for brush or spray application; be an air-dried material; contain no oil of any kind; must establish a water-and-steam tight film which will be durable under any pressure or temperature to which it will be subjected in a locomotive boiler for at least five years; must not retard heat transfer when applied to heat transfer surfaces; must be unaffected by any boiler feedwater treatment; must not be affceted by any of the thermal or mechanical shocks to which the locomotive boiler may be subject; must not cause priming or foaming; must establish a film having the ability to withstand, without destruction of its effectiveness, reasonable mechanical abuse upon installing flues in the boiler; and must be durable under the conditions to which it may be subject when locomotives are placed in storage.

Advantages of Boiler Coatings

Given a coating, meeting the essential requirements above, the following advantages may be had from its application to boiler shells, firebox crown sheets and side sheets, wrapper sheets and flues:

a.—By establishing a water-tight barrier on the boiler steel, the coating insures protection against the possibility of corrosion due to any elements which may be present in the boiler water. And it will provide this protection from one flue removal period to the next.

b.—It will help to reduce maintenance costs by eliminating the corrosion or pitting which frequently requires extensive patching or replacement of shell or firebox metal.

c.—It will help insure that flues removed are in better condition for safe-ending and re-use, thereby reducing expenditures for flues.

d.—It will help toward increasing the availability of the locomotive by reducing the amount and time of boiler repairs.

e.—It will guard the internal surfaces of locomotive boilers stored dry in good order.

The following additional advantages accrue where the coating minimizes the amount and bonding of operating deposits:

f.—Cleaner evaporating surfaces during operation which in turn means better heat transfer and a contribution to a higher thermal efficiency.

g.—Easier and more effective cleaning at boiler wash periods.

h.—Easier, more thorough, and quicker cleaning and inspec-

tion at flue removal periods. Shells may be scaled as required by I.C.C. Regulations with minimum recourse to air scaling tools. Flues may be cleaned more easily by rattling or whatever other descaling procedure is used.

Reports from many railroads attest the durability of the coating, and its effectiveness in minimizing pitting. One road with extensive experience in the coating of boiler shells has found that the average time for thorough scaling of shell metal was reduced from 3 days for a bare shell to 1½ days for a coated shell. Another road reports that pitting which existed prior to coating is arrested and the tendency to pit is eliminated. Moreover, the removal of scale is much easier after four years of service as the formation of heavy scale on the shells is retarded. A third line reports an increase of flue life from 2½ years to a full 4 years and with the flues generally in good condition for further service; also flues remain cleaner in service and clean very easily when they are removed.

Preparation of Surfaces

It is a fundamental requirement for an initial application of the coating that all surfaces be so prepared that the coating bonds directly on bare metal. This means that new shell plates, firebox plates, wrapper sheets, etc., and new flues should be free of mill-scale; and shells or flues which have seen previous operation should be free of scale deposits formed during such previous service. All plates, new or old should be abrasively-blasted (using either sand or steel grit) to deliver this condition. Flues should be prepared by abrasive-blasting, pickling, or any alternate procedure which will deliver a scale-free surface. Cleaning in the rattler is of doubtful effectiveness.

It must be remembered that the construction of the locomotive boiler is such that any touching-up or repair of the coating cannot be performed once the boiler is complete.

When locomotives, whose boilers have been previously coated, are shopped for flue renewals, preparation of the shell for recoating is somewhat more simple than for initial application. It is generally unnecessary to re-blast the surfaces; the presence of the previously-applied coating will make complete removal of operating deposits an easy matter and the coating film remaining on the surface will provide a proper foundation on which to recoat.

Before coating, any surface should be free of oil or grease, and any dirt or rust which may have deposited or developed on such surfaces after the original descaling operation. Reasonable precautions should be taken to minimize mechanical damage to the coating in completing the fabrication of the boiler after the various parts are coated. Some scratching or apparent marring of the coating attendant on installing the flues is inevitable, but where the bond is secure on scale-free metal such damage will be only on the surface. There may be some reduction in the depth of coating where scraping occurs but the penetration of the coating into the pores of the metal will insure that continuity of protection remains.

Interior of Tenders

Since the services to which internal tender surfaces are subject is of much less severe character than that of locomotive boilers, it follows that the requirements to be met by a coating suitable for tender application are less rigid than those for the boiler coating. A suitable internal tender coating must have a high flash point; be non-toxic; be suitable for brush or spray application; be an air-dried material; establish a water-resistant film which will remain effective and durable between annual inspections under conditions of water temperature to which it will be subject and it must remain fully effective on dry surfaces when tender is out-of-service and stored for indefinite periods.

Given a coating, meeting these requirements, its application to the internal surfaces of tenders means the maximum of security against corrosion, ease of cleaning and inspection, decreased cost of repairs occasioned by corrosion and deterioration of tender sheets, and effective protection out-of-service as well as in service, with assurance that tenders of locomotives stored in good order will be ready for service when required by traffic conditions.

Ideal preparation of metal in the case of new tenders for certain types of coatings is had by abrasive-blasting or pickling of the plates prior to fabrication and with the paste type materials the requirements are that the surfaces of the sheets be clean and free from rust, grit or other conditions brought on by oxidation, thereby insuring that the coating is not subject to breaks in continuity incident on the disengagement of mill-scale, or continued corrosion due to insufficient cleaning of oxidized surfaces. Preparation of old tenders should be by the most thorough mechanical cleaning feasible, to effect removal of all dirt, loose rust, or other substance which would prevent adequate bond.

Providing Proper Ventilation

Because of the confined nature of the areas in which the work must be carried on, thorough ventilation is important for the comfort of the workmen. Entirely satisfactory working conditions can be established by attaching to the tank hose outlets in the two front corners of the tender proper sized blowers or exhausters. These blowers will serve to draw fresh air into the tender through the filling hole, and the movement of the fresh air will be forwarded from the filling hole to the blowers. By starting in the front corners and working toward the rear, the workmen will at all times be out of the fumes or vapors given off in the drying of the coating. Ventilation should be continuous at all times during the work and should be maintained after the application of the coating until thorough drying is accomplished.

While the practice of coating boiler shell sheets, tubes, flues and tender cistern sheets has not been experimented with by a large number of railroads, the application has been made to a few thousand locomotive boilers and tenders over a period of many years. The encouraging reports of those roads that have made use of the practice, definitely demands that this method be continued and its use extended on a much broader scale, for in the absence of chemical treatment that will reduce or control this remaining type of pitting and corrosion coating appears to be a proper and logical step. The volume of repairs now being made to locomotive boilers and tenders and the scrapping of flues directly due to some form of pitting or corrosion, constitutes the major portion of boiler maintenance, and as such present a good field in which to extend improvement and reduce still further the cost of boiler maintenance.

The members of the committee were E. H. Heidel (chairman), general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific; F. R. Milligan (vice-chairman), general boiler inspector, Canadian Pacific; G. E. Lauderbach, supervisor of steam power plants, New York Central; F. J. Zink, general boiler inspector, Chicago, North Western; B. B. Millikan, assistant general boiler inspector, Chicago, Rock Island & Pacific; I. J. Derermer, general boiler inspector, Chicago, Burlington & Quincy; L. W. MacLean, manager, The Dampney Company of America; A. A. Edlund, assistant general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific; L. A. Roberts, assistant supervisor boilers, Boston & Albany.

Discussion

F. E. Godwin, mechanical inspector, Canadian National, said that many years ago the C. N. painted the rivets behind the carrier bars but did not have much success with it. Instead a method was adopted of putting in a deflector plate, covering the two rows of rivets on the mud ring, protected between the deflector plate and the rivet heads by asbestos, and this has done a remarkably good job. The only thing that requires protection is the asbestos against getting wet, and if this is done the rivets will remain good indefinitely. The deflector plate is applied 1½ in. above the top row of rivets and is seal-welded so that no water will get down when washing grates or bars. It is clipped at the bottom under the caulking edge of the side sheet.

(During the discussion it was emphasized that coating the boiler will help to eliminate those types of pitting which have not been overcome by feed water treatment, and it is in no way a substitute for water treatment. Several examples were quoted where boilers have not pitted with service up to 15 years when coated, and where pitting that existed prior to coating was arrested completely and proceeded no further. One road also reported that where previously flue life was from 30 to 46 months all now run 48 months, and that where previously a quarter of the flues was scrapped, this has been eliminated and the flues are a lot cleaner—Editor.)

Advantages of Steam Space Spray Boiler Checks

From operating records submitted by the various railroads there can be no doubt concerning the merits of the top boiler check application. Stresses that were previously set up within the boiler by the induction of cold water from the side check are eliminated, as the top feed produces a constant temperature throughout the whole boiler. Improved water circulation increases boiler thermal efficiency and the ultimate results are a reduction in firebox and boiler maintenance, with increased service life on firebox side sheets. The side boiler check application seems to have outlived its usefulness and has no place in modern boiler efficiency.

The Virginian reported a bad grooving condition developed on compound Mallets around staybolt holes, tube sheet flanges and boiler shell courses. We believed this grooving condition was caused by excess oxygen in the feed-water which entered the boiler through side checks in a solid stream where the oxygen could not liberate itself. Tests were conducted after applying a right and left inside feed pipe to the side check and extending to the top of the boiler above the dry pipe converging into a horizontal perforated pipe, 2½ in. in diameter, 34 in. long, with 34½-in. drilled holes, and clamped to the dry pipe giving the same effect as a top boiler check with spray nozzle. The application of these inside feed-water pipes has entirely eliminated all trouble from grooving.

The Washington Terminal reported less leakage at staybolts on boilers equipped with top boiler checks than with the side boiler checks but a much better performance on locomotives equipped with the top check and spray nozzle than those equipped with side boiler checks or top boiler checks only.

The Grand Trunk Western reported that since the boiler side checks were removed and replaced by boiler top checks, side sheets staybolts leakage has been reduced to a minimum. The application of the top check to any class of power will greatly increase the service life of the firebox sheets and doubly so if the locomotives are equipped with thermic syphons or circulators.

The Canadian Pacific reported that they have discontinued the use of side checks in favor of the top check years ago on all classes of power. No spray nozzle attachments are used, and no records are available of increased side sheet life from this application.

The Chicago and North Western reported that the top check application improved water circulation within the boiler, and that salts held in solution in the feed-water are precipitated to a great extent, settling at the bottom of the boiler barrel in the form of a sludge which is easily washed out.

The Canadian National has long been an advocate of the top boiler check. All locomotives are equipped with a double top boiler check with deflector type tail piece. The performance of 20 Mountain-type locomotives put in service at the beginning of 1945 until the first retube repair have accumulated 8,341,019 miles, an average of 417,000 miles. It was found necessary to renew half side sheets on four locomotives; six required patches on side sheets; the remaining ten required no firebox repairs.

Increased firebox performance is not the result of any one method but rather a combination of top check, oil separators, proper cooling down and firing-up methods, and a good water treatment program.

The steam space spray boiler check is not a recognized check but rather an improved tail piece added to the standard top boiler check arrangement, to diffuse the feed-water and is accepted by some railroads as a decided improvement increasing boiler efficiency. Other railroads report that when the steam demand is greatest or when trading steam for water that the spraying effect of the feed-water in the steam area creates a carry-over condition, reducing performance.

Members of the Committee were F. E. Godwin (chairman), mechanical inspector, Canadian National; W. F. Wollard (vice-chairman), system boiler and welding foreman, Chicago & North Western; W. H. Keiler, Interstate Commerce Commission locomotive inspector, Bureau of Locomotive Inspection; C. R. Kirkwood, supervisor of boilers, New York Central; J. J. Desmond, roundhouse foreman, Washington Terminal; C. L. Leet, service engineer, Combustion Engineering Company, Superheater Division.

Discussion

Secretary Stiglmeier said that the New York Central does not weld staybolts because they believe that they have solved the problem of staybolts in side sheets with the top check. The side sheet life has been prolonged with the top checks and some locomotives are now going into four different shoppings with the same side sheets. The N. Y. C. has some trouble with corrosion and pitting but water service engineers believe that the top check will overcome some of this trouble.

L. J. Johnson, Jr., general boiler maker foreman, Florida East Coast, said that his road has used the top boiler check exclusively since 1908. They get around 300,000 miles between flue renewals and have some side sheets that have been in service since 1926 with no leaky staybolts.

C. L. Leet, service engineer, Superheater Company, said by changing the location of the boiler check valve on the New York Central side sheet life was increased from about 100,000 miles to 480,000 miles average.

Proper Brick Setting for Oil and Coal Burning Locomotive Fireboxes

Before installing an arch, the spacing of the arch supports should be checked to be sure that they are within design tolerance. Due to temperature changes within the firebox and also vibration of the locomotive, some types of supports have a tendency to move out of line. If they are checked regularly, longer brick life will be obtained.

As the contour and length of the arch are calculated to suit firing clearances, combustion volume, and gas areas, the arch should be maintained according to specifications at all times. The area over the arch is designed to be, and should be kept, at from 110 per cent to 130 per cent of the gas area through tubes and flues. Any change made in the calculated length of the arch will alter the gas velocity through the firebox, thereby affecting its efficiency. When a tight fit between the various patterns cannot be obtained, small openings should be carefully filled with a mixture of broken brick and fire clay.

Side brick patterns in locomotives equipped with arch tubes are specified on drawings to set at an angle of approximately 40 per cent. If this angle be higher, the brick may tip backwards due to draft. If lower, the brick will have a tendency to wedge between the arch tube and side sheets, resulting in either cracking the brick or forcing the arch tube out of line.

Oil Burning Installations

The pan on oil burners should be tight and of rigid construction to prevent jarring and vibration being transmitted to the brick lining. All firebox and supporting joints should be air tight to prevent infiltration of air causing loosening brick work and disturbance in combustion processes, Fire pans should be thoroughly cleaned of all slag and carbon accumulations prior to applying a setting in order that the brick may be laid tight

against the fire pan and firebox sheets. Brick laid carelessly will not only work out of place and cause trouble, but where open joints occur, the sand used for flue cleaning will work under the brick and force it out of place.

Some railroads are using small 9-in. patterns for lining fire pans but rapid transition is being made to the use of large refractory shapes. The large shapes are recommended for both economical and practical reasons. As there are fewer patterns to handle, man hours for application are reduced. They are easier to store and reduce time spent when taking inventory. Due to elimination of the majority of joints there is less time spent in applying mortar. The reduction in the number of joints also increases service life of the lining as the trouble spot of a refractory application is at that point.

When constructing the flash wall, care should be taken to make certain that each course is well balanced to prevent toppling and also, full use should be made of the tongue and groove in each pattern so they are properly interlocked.

Refractories should be applied with minimum thickness of joints and bonded with a suitable fire clay or cement mortar that will set within a close range of the maximum furnace temperature developed. A thin coating of this same clay should then be brushed over all exposed surfaces and be allowed to dry out for at least one hour before firing. It is also beneficial to fire boiler with hot water and use blower to expedite drying.

The members of the committee were H. R. Barclay (chairman), general boiler inspector, Northern Pacific; H. C. Haviland (vice-chairman), supervisor of boilers, New York Central; H. M. Cooper, regional boiler inspector, Baltimore & Ohio; T. H. Moore, general boiler inspector, Western Maryland; M. R. Francis, general boilermaker, Norfolk & Western; W. B. Graham, mechanical inspector, Gulf Coast Lines, Missouri Pacific; H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe; H. E. Gregory, assistant boiler inspector, Canadian Pacific; W. S. Doughlas, chief boiler inspector, Canadian National.

Discussion

L. J. Johnson, Jr., Florida East Coast, said that his road uses a round burner with 10 atomizer slots around the oil opening and it gives perfect atomization and combustion. The F. E. C. formerly set the burner at the table plate from 7 to 8 in. where it struck the platform with an up-angle toward the flash wall, and this resulted in carbon due to the flame drag in the pan. An arched table plate is now used with the burner 14 in. at the mouth down to 12 in. at the flash wall, and carbon is eliminated. Brick requires renewal only at annual inspection.

J. B. Tracy, Central Refractory Company, said that when the Missouri Pacific changed from laying up their pan with fire clay to a high-temperature air-setting cement the cost was halved, and since then the M. P. has used the air-set cement exclusively. J. D. Johnson, chief boiler inspector, Missouri Pacific, added that troubles with laid brick becoming loose from premature explosion is eliminated where an air-set cement is used.

Procedure for Seal Welding Staybolts

Following is the procedure recommended in applying seal welded staybolts:

1. Clean off sheets by sand blasting or grinding before staybolt holes are tapped.
2. Tap out staybolt holes from outside of firebox.
3. Screw in staybolts from outside making sure they are a snug fit.
4. Remove all oil from firebox sheets, staybolt holes and ends of bolts.
5. Cut off bolts to driving lengths at outer ends.

By preparing the firebox end as follows the life of firebox plates has been doubled and leakage reduced to minimum:

1. Staybolts that are seal welded are applied in the usual manner, heads driven on the outer ends and held on with a heavy dolly bar approximately 60 lb. weight, then driven on the inside using a flat die in an air hammer not working the edge of head down to the sheet. A cutter in the air motor chamfers the head 30 deg. to the junction of the threads in the sheet at the same time removing mill scale and any foreign matter adjacent to the staybolt end, clean bright metal is obtained 3/16 in. around the outer end to be welded. Welding is started at the bottom center and continues all the way around without breaking the arc.

2. Chamfer the end of the bolt to a 60 deg. angle before it is applied to the side sheet, then screw the bolt in with a snug fit so that the chamfered end projects 5/32 in. inside of the sheet. The welding of each bolt is made in two passes, the first pass starting past center top and down one side of the bolt past the bottom center; the second pass is on the other side of the bolt and overlaps the other half of weld.

3. Apply the bolt in the usual manner; drive the bolt on the outer end with tit snap, holding on with 60 to 80 lb. dolly bar; then drive inner end of bolt with tit snap; properly clean sheets and weld starting past center top and down one side of bolt past bottom center; the second pass on the other side of bolt overlaps other half of weld. Then seal weld staybolts using 1/8-in. electrodes, AWS E-6010 or E-6012.

Seal-Welding Taper Bolts

The procedure for seal-welding taper bolts on New York Central Niagaras with 522 crown bolts on each is as follows:

The crown bolt holes are tapped and the bolts threaded, applied and cut to length for driving on the wrapper sheet end, the crown sheet end is held on and the bolt driven.

After the crown bolts are driven and all other boiler work completed, the boiler is subjected to a hydrostatic pressure of 300 lb. All crown bolts leaking on firebox end are replaced. Following the hydrostatic pressure of 300 lb., the oil and other foreign substances which may have entered the boiler in course of repairs are boiled out as follows:

1. Remove dome cap.
2. Fill boiler with warm water to two gauges.
3. Apply 200 lb. of an approved chemical cleaning agent through dome cap opening.
4. Apply steam line to front corner mud ring washout plug hole and allow water in boiler to boil four hours.
5. After boiling for the prescribed time, apply warm water line to blowoff cock and allow water to overflow through dome opening for three hours.
6. Drain boiler, remove plugs and wash boiler.

With water in the boiler, the firebox end of crown bolt is cut to length with a torch leaving four full threads projecting through the sheet. The crown bolts are then faced off, using a facing tool. The threads are removed from bolts projecting through the fire side of the crown sheet preparatory for welding, using a special tool.

After the crown bolts are prepared for welding, the entire area of the crown sheet where the crown bolts are to be welded is dry sandblasted, after which one-half of the circumference of each bolt is welded. All crown bolts are again sandblasted to remove the flux, after which the unwelded part of the crown bolts is welded. After the welding of all crown bolts is completed, thoroughly clean by sandblasting for final inspection. Material used for the welding of crown bolts is AWS-6012 5/32-in. electrodes, or equivalent. The boiler is tested 25 per cent above working pressure and all welds inspected under pressure.

The committee members were Floyd R. Seeley (chairman), general boiler inspector, Union Pacific; B. G. Kantner (vice-chairman), general boiler inspector and welding supervisor, Reading; J. D. Johnson, chief boiler inspector, Missouri Pacific; C. A. Norton, general boiler inspector, Canadian National; R. A. Culbertson, general master boiler maker, Chesapeake & Ohio;

A. P. Robersen, district boiler inspector, Great Northern; V. C. Vogel, welding supervisor, Chicago, Rock Island & Pacific; C. E. Tolen, welding instructor, Cleveland, Cincinnati, Chicago & St. Louis; O. H. Kobernick, general boiler supervisor, New York, Chicago & St. Louis.

Discussion

J. D. Johnson, chief boiler inspector, Missouri Pacific, reported on two 285-lb. locomotives with seal welded staybolts that have run about 200,000 miles. Out of a thousand bolts applied, about 200 hair-cracked at the front and back end of the bolt after about 2 months' service, but none ever leaked a drop and none have been renewed.

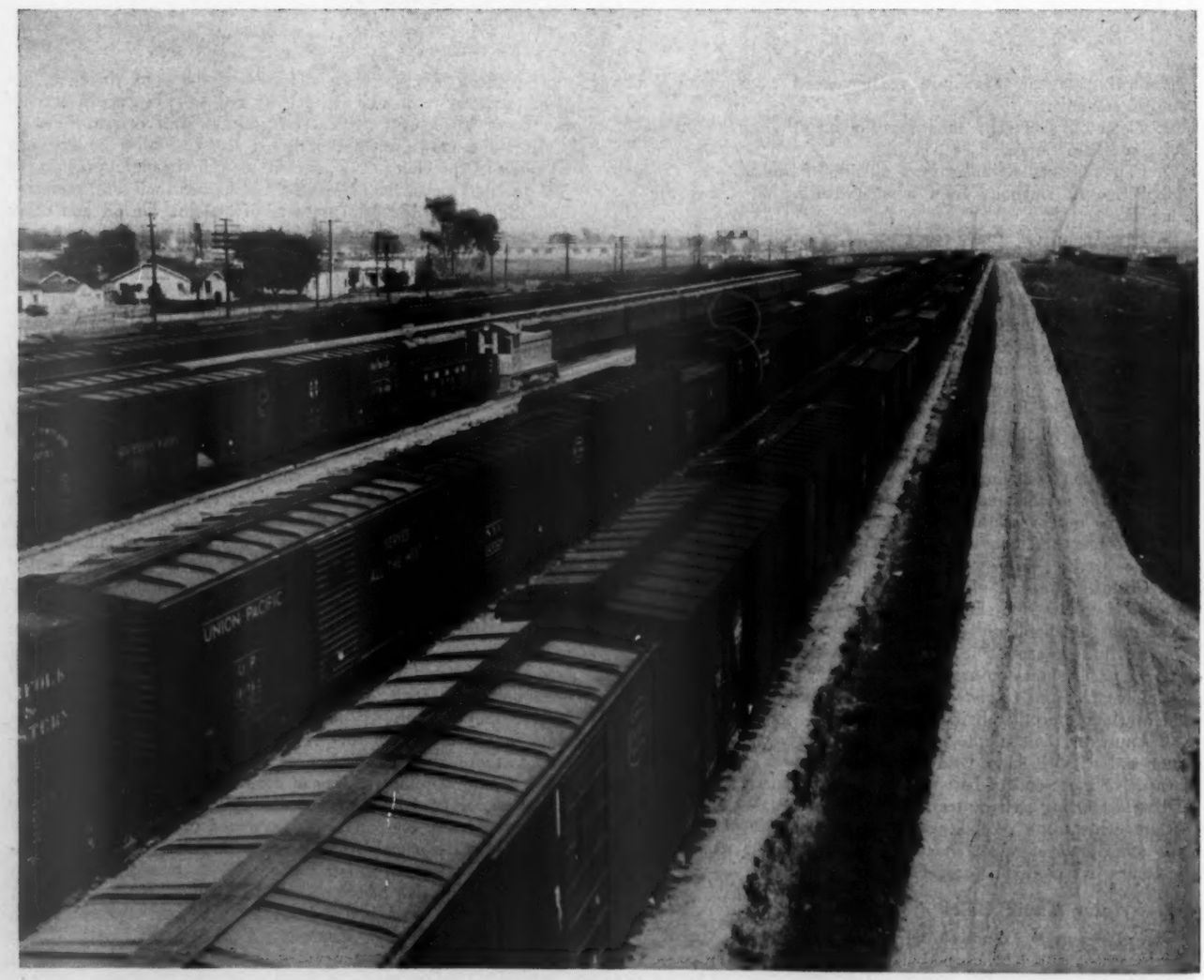
H. H. Service, general boiler inspector, Atchison, Topeka & Santa Fe, described an application of mild steel staybolts to the side sheets which was done by turning the firebox over on the side and welding downhand, using E-6013 electros, single bead work. The bolts have not been touched since application.

R. W. Barrett, chief boiler inspector, Canadian National, said that when driving either iron or steel bolts and holding with a 60-lb. dolly there is a tendency for the helper to get tired and the bolt is driven like a drum on an open plate. Proper holding will lessen the danger of forming hair checks. He mentioned that several years ago objection was taken to the application of button head staybolts as they increased the holding strength of the crown sheet and in the event of low water the crown would resist to the point where a terrific explosion resulted. Seal welding the taper bolts likewise increases the holding strength of the crown sheet. The Canadian National advocates the strong and weak zone method. In this there are four rows of button heads and four rows of straight parallel bolts, and with this method there has not yet been a case of law water where the engineman has not stepped off the cab. The weak zone gives out, putting out the fire while the strong zone holds the crown sheet and prevents a major explosion.

F. R. Milligan, general boiler inspector, Canadian Pacific, said that the C. P. applied button head crown bolts and staybolts without any thread on the firebox of one 285-lb. locomotive, putting 42 staybolts in the area below the arch, a section that cracks quite a little. This was about 3 years ago and there has been no trouble; none has been touched and none has leaked. There has been no burning of the hands. By leaving the square on button head bolts the strength is increased substantially.

Experience with the Miller-Grant all-welded staybolt on Milwaukee Road 285-lb. boilers appeared to have been successful. After 11 months and between 70,000 and 80,000 miles in heavy freight service none of these bolts has been found to leak.

* * *



Road Foremen Discuss Diesel and Steam Locomotive Operation

W. E. Sample
President
(Superintendent fuel conservation, B.&O.)

G. E. Anderson
Vice-Pres.
(General fuel supervisor, Great Northern)

R. H. Francis
Vice-Pres.
(General road foreman, equipment, St.L.-S.F.)

L. H. Peters
Sec.-Treas.

In a full three-day program, the Railway Fuel and Traveling Engineers' association considered 15 addresses, reports and papers dealing specifically with various problems pertaining to the training of engine crews for operating Diesel locomotives in the yard and on the road and with problems relating to steam-locomotive fuels. In addition, papers were presented on the relation of water treatment to fuel economy on steam locomotives, the education of steam locomotive crews, and braking control of passenger trains.

The principal addresses were delivered by George A. Mueller, assistant to president, Lima-Hamilton Corporation, and by James Hyslop, president, Hanna Coal Company. Mr. Mueller's subject was Adaptability to Change, and he reviewed the rapid changes which have taken place in transportation, particularly during the past century.

Mr. Hyslop described the methods of cleaning and preparing coal at some length. These, he said, the bituminous coal industry had been forced to adopt. He commented on the importance of the coal and railway industries to each other and called attention to the sharp drop in the amount of coal burned by the railroads during 1949. He also emphasized the fact that there are not enough cars in serviceable condition to meet the coal traffic demands. He also spoke of the importance of the cost of coal movement. The movement by belt conveyor which has been under discussion, he said, would not be as economical as movement by rail, but that it would cost less than movement by rail at present rates. This, he felt, needed adjustment.

Others who spoke informally were E. H. Davidson, director, Bureau of Locomotive Inspection, Interstate Commerce Commission, and J. J. Brinkworth, vice-president, New York Central System. Mr. Davidson referred to oil leaks on Diesel-electric locomotives which are the cause of a considerable number of accidents. He emphasized the favorable position of the traveling engineer to help in the effort to keep the number of those accidents down.

Mr. Brinkworth, who is an executive consultant of the association, emphasized the importance of smoke prevention. All over the country, he said, the smoke question is becoming of increasing importance to the people living in large cities. This is a problem, he said, for the members of the Railway Fuel and Traveling Engineers' Association. He paid tribute to the late A. A. Raymond, superintendent fuel and locomotive performance, New York Central, for his pioneer work in smoke prevention. Mr. Brinkworth expressed himself strongly in favor of getting settled the present labor difficulties which have led to government control. The sooner a settlement can be reached, the better it will be, in his estimation, for the industry as well as for the individual employees. He spoke of the responsibility of the traveling engineers for the prevention of accidents and particularly the need to exert their influence for careful observation of signal indications.

The program this year contained ten items dealing with various aspects of Diesel-electric locomotive operation, including the management of the locomotive itself, tonnage rating, yard operation and train handling. Five of the papers were prepared by railway men. Five were in the nature of presentations from the operating manuals of the locomotive builders and the builders of train-heating equipment.

W. H. Fortney, chief road foreman of engines, Big Four district, New York Central, presented a paper on the methods employed by his railroad in instructing crews in Diesel locomotive operation. Z. Heskett, special engineer, Baltimore & Ohio, dealt with the tonnage rating of Diesel

locomotives. M. G. Stewart, Washington Terminal Company, discussed Diesel-electric yard operation, and papers were presented by R. H. Francis, general road foreman equipment, St. Louis-San Francisco, on Handling Freight Trains with Diesel Locomotives and by P. A. Quarles, Atchison, Topeka & Santa Fe, on Controlling Trains with the Dynamic Brake. Mr. Francis was also the author of a paper on the Abuse of Diesel Locomotives.

The following builders' papers were presented: On-the-Road Trouble Shooting, by D. Martin, service engineer, Electro-Motive Division, General Motors Corporation; Operation and Trouble Shooting, by S. Lodge, American Locomotive Company; the Alco-G. E. Electrical Equipment, by H. R. Hill, General Electric Company; Operation of the Elesco Steam Generator, by C. A. Leet, Superheater Company, division of Combustion Engineering Corporation-Superheater, Inc.; and Operation of Vapor Steam Generators, by G. C. Scott, Vapor Car Heating Corporation.

R. A. Williamson, manager, railroad rolling-stock division, Locomotive and Car Equipment Divisions, General Electric Company, described the special features of a gas-turbine electric locomotive and told of the experience with the G. E. turbine locomotive on the Union Pacific.

Papers pertaining to steam locomotives and their fuels are as follows: Locomotive Fuel Oil, by G. E. Anderson, general fuel supervisor, Great Northern; Coal Characteristics and Performance of Road Locomotives, by E. D. Benton, director, Division of Research and Fuel Engineering, Ohio Coal Association; Education of Steam Engine Crews, by A. H. Glass, chief power and fuel supervisor, Chesapeake & Ohio; Co-ordination in Control of Railroad Smoke, by H. C. Ballman, smoke regulation engineer, Columbus, Ohio; Water Treatment and Fuel Saving, by A. G. Tompkins, supervisor of water treatment, Baltimore & Ohio.

R. G. Webb, superintendent of air brakes, Chicago, Milwaukee, St. Paul & Pacific, was the author of a paper on Braking High-Speed Passenger Trains. Because of his death a few days before the convention, his paper was presented by J. M. Hemsey.

The following officers were elected to serve during the ensuing year: President, G. E. Anderson, general fuel supervisor, Great Northern. Vice-presidents: R. H. Francis, general road foreman equipment, St. Louis-San Francisco; R. D. Nicholson, road foreman of engines, New York, New Haven & Hartford; Glenn Warner, fuel supervisor, Pere Marquette district, Chesapeake & Ohio. Members of the Executive Committee: F. T. McClure, general supervisor air brakes, Atchison, Topeka & Santa Fe; T. J. Conway, fuel supervisor, Texas & Pacific; O. D. Teeter, fuel supervisor, Denver & Rio Grande Western, and C. M. Moddrell, supervisor fuel and locomotive performance, Northern Pacific.

President Sample Speaks

In opening the convention President Sample reminded the members that throughout its history the purpose of the association has been to improve the locomotive service of American railroads and, in carrying this out, to assist in the education of all whose duties pertain to locomotive operation. "Our various committees," he said, "have played a vital part in making the locomotive a more economical machine." The continued success of the association, he said, depends in large measure on the individual interest of the new and younger members. These he advised to participate actively in the affairs of the association.

The opening address was to have been delivered by D. S. Ellis, then president of the Lima-Hamilton Corporation. Because of his inability to be present, George A. Mueller, assistant to president of the same company, spoke. Abstracts of his address and a number of the reports and papers follow.

Mr. Mueller's Paper

There is a distinct contrast between our worried and hurried world of today and the placid and easy-going world that existed a century ago. There can be no doubt in anyone's mind but that this last century and more specifically, the last forty years, represent an age of extreme development in all the various branches of knowledge. The arts and sciences have progressed at an amazing rate—so great a rate, in fact, that for the past decade, most of us have been kept so busy and so active with our daily tasks that we have not had time enough to look at the distinct and remarkable contrast that exists between life as we know it now and life as it was years ago.

Regardless of which field of endeavor we scrutinize, we can notice the same remarkable and extremely rapid development. Over a generation or two, we have become witnesses to such major developments as the growth and decline of whole transportation systems. Practically all of the people in this room remember the declining years of the canal systems. Interurban and electrified railway systems sprang up concurrently throughout the nation. Because of the rapid development of competing systems of transportation, the electrified systems also died off.

The rapid adoption of Diesel electric power by the railroads is, of course, familiar to all.

This is part of what has gone before. What the future holds for the American railroads is difficult or impossible to predict. However, a glimpse of things to come is afforded by the contemporary research and development programs now under way.

Most of the locomotive builders are at work on gas-turbine power plants, pointing to the ultimate utilization of the heavier and cheaper petroleum fuels or coal. There is serious activity under way, not only to develop machinery to burn powdered coal, but also to develop modified Diesel locomotives operating on gasified coal.

Not long ago, I saw in the research laboratory of an Eastern university, a standard high-speed Diesel engine operating on about forty per cent fuel oil and sixty per cent powdered coal. The coal was so finely pulverized that after mixing with fuel oil, it remained in suspension and could be handled as a liquid through the engine fuel-injection system.

In surveying all of these rapid advances, one fact becomes self-evident. As we study our modern way of life, all of these advances are distinctly tied in with the equally fast development of man's mechanical ability to design highly complex specialized machinery. And, what is equally important, to maintain this intricate machinery, to permit the practical application of the newly found principles. We must have an organization technically trained to maintain these machines and structures in such condition that they can continue to operate day after day, year after year, in an effective and efficient manner.

Where the old shop years ago had its supply of lubricants represented by a drum of sticky grease and another drum of lubricating oil, we now find that highly developed, specially compounded lubricating oils and lubricating materials are so numerous that few people are acquainted with all of the uses of the various individual products. We find that we have the silicones that can be considered as lubricants or insulating materials or which they can be made. We have new ferrous and non-ferrous

alloys. These things and the countless new items cropping up daily require highly trained and technically educated personnel for proper application to the maintenance job.

In looking at the specific case of the modern Diesel electric locomotive, efficient and satisfactory maintenance organizations and programs are now being worked out. A short while ago it was felt that the use of this more efficient power had increased so quickly that the maintenance personnel had no chance to comprehend the full scope of their responsibilities.

The situation has now changed. After much study, and many sad experiences in the field, the maintenance and service schedules focus attention on the smallest of items. These schedules are set up on the fundamental premise that if the smaller component parts of the Diesel are properly looked after, the larger assemblies and the locomotive as a whole will be satisfactory.

The difference between acceptable steam locomotive maintenance and Diesel electric locomotive maintenance is becoming greater daily because of the realization of the far greater complexity of the Diesel electric locomotive.

Modern manufacturing and servicing methods have become so proficient that a tolerance of .001 in. is an everyday figure. Such tolerances and the close fitting that results have presented a new problem in their demands for careful storage and handling and entirely new conceptions of cleanliness.

Whether or not the roads continue to obtain the economies predicted by the performance of new equipment is in your hands.

Gas-Turbine-Electric Locomotives

By R. A. Williamson,

Manager, Railroad Rolling-Stock Division, Locomotive and Car Equipment Divisions, General Electric Company

A gas turbine is an internal-combustion engine like a gasoline or Diesel engine. It burns fuel directly in, or close to, the operating engine and the products of combustion constitute the working fluid. Thus, it differs from the usual steam-engine or steam-turbine plant, where fuel is burned under a separate boiler which transfers the heat to an independent medium like water and forces that medium through the engine. There are a great many possible kinds of gas-turbine power plants, but I will discuss only the three which have so far been chosen for locomotive use: (1) Single shaft, either plain or with regenerator; (2) double shaft; (3) free-piston gas producer with power turbine.

The plain single-shaft open-cycle plant involves an air compressor which takes in air, compresses it to several times atmospheric pressure, forces it through a combustion chamber, where heat is added by burning fuel, and then through the turbine, which drives the compressor and connected useful load. To recover some of the exhaust heat otherwise wasted up the stack, a heat exchanger between the turbine exhaust and compressor discharge may be added. This is usually called a "regenerator."

The double-shaft plant uses two separate turbines and one or two compressors. One turbine and compressor operate as a unit furnishing hot gas to the other, which may drive the useful load only (if a turbine alone) or assist in producing hot gas (if the second turbine drives another compressor as well).

The free-piston gas producer is essentially an opposed-piston Diesel engine without a crankshaft. It produces no mechanical power but the exhaust supplies hot gas to a power turbine.

Like a gasoline or Diesel engine, the single-shaft gas turbine has no torque at standstill, since there is nothing to force the working medium through the engine until the compressor starts to turn. It must be cranked like an engine and will supply useful power at the shaft between about half and full speed. In locomotives, it demands the standard direct-current generator-traction-motor drive used with Diesel engines. The power turbine of either the two-shaft gas turbine plant or the free-piston gas-producer-turbine plant can deliver torque at all speeds from full down to zero; therefore, it is possible to use other forms of drive with them.

[The author here reviewed the present world status of gas-turbine locomotives, of which there are 10 now built or projected. These are two built by Brown-Boveri in Switzerland—one for the Swiss Federal Railways and one for the Western region of the British Railways; one being built by Metropolitan-Vickers Electrical Company in England for the Western region of the British Railway; one by Alsthom for the Mediterranean-Nigeria Railway, concerning which little information is available; two to be built by the Baldwin Locomotive Works—one now under construction for the Atchison, Topeka & Santa Fe, and the other being designed for the Locomotive Development Committee; one which has been built by the Westinghouse Electrical Corporation; one involving the free-piston gas producer being built by the Lima-Hamilton Corporation for the Pennsylvania; and the General Electric Company's locomotive which is in service on the Union Pacific. His report on this locomotive follows.—Editor.]

Our own locomotive is a 4,500 hp. freight unit with a single-shaft power plant burning Bunker C oil. It has no regenerator. A small boiler operated on Diesel fuel heats the Bunker C oil, and a Diesel-generator set is used to supply auxiliary power and air when the main turbine is not running. Preliminary testing was done on our Erie test track in late 1948, and on the Pennsylvania and Nickel Plate in early 1949. In July it was sent to the Union Pacific for extended testing in regular freight service, and is still there. It was run first between Los Angeles, Calif., and Salt Lake City, Utah, for high altitude and hot weather testing, then between Green River and Cheyenne, Wyo., and is now running between Cheyenne and Council Bluffs, Ia. Up to September 3 it had run 55,000 miles in freight service, produced 184,391,000 gross ton-miles, and burned about 899,000 gallons of oil. This corresponds to an average load of 3,350 tons, against about 3,000 tons for 4,500-hp. three-unit Diesel-electric freight locomotives on the Union Pacific.

Now, what have we found out so far?

Five hundred hp. per axle is a figure often tossed about as a limit beyond which locomotives become "slippery." Our locomotive is rated 562 hp. per axle and under favorable conditions will develop 675; therefore, many prophesied it would be "slippery." Actually it has acquired an enviable reputation for being exactly the opposite. This may be due to the 20-notch control, circuit arrangements, and running gear characteristics.

Although this locomotive was built double-ended, nobody has ever used it that way, so we have closed up one operating cab and installed additional fuel capacity there.

Trouble was expected in tunnels because of possible exhaust recirculation into the main air intake. Elaborate tests have not been made, but we have operated the locomotive at very low speeds forward in several tunnels without any difficulty. It is not possible to back into the exhaust indefinitely, for obvious reasons.

We effected a noticeable improvement in overall fuel economy by discarding the direct air-brake compressor drive and installing a motor-driven compressor. This enables us to pump up trains before starting the main turbine, and to shut down the main turbine when making extended meets along the road.

There are limits to the range of fuel oils which can be burned, from the standpoints of both heating and filtering limits and ash content and nature. We are continuing tests aimed at establishing what these limits are.

All in all, we are gratified with the information so far obtained, and expect to keep the locomotive in further operation to shed more light on the future.

Instructing Crews in Diesel Locomotive Operation

By W. H. Fortney

Chief road foreman of engines, Big Four District, New York Central

Eight different engine crews operate the same locomotives between Harmon, N. Y., and St. Louis, Mo., so it is very important that uniform and proper instructions be given and understood by all concerned for good performance.

On the New York Central System we have a definite set of instructions to follow, issued from our New York Office, and all supervisors instruct engine crews according to these instructions, regardless of type of locomotive. In that way we do not have conflicting instructions and do not confuse the enginemen in operation. We have had representatives from different manufacturers state that it is not necessary to reduce the throttle to No. 3 position over railroad crossings, or No. 4 position when braking a train, etc., stating it restricts the performance of their locomotive. Nevertheless, we instruct our enginemen to operate Diesels, regardless of type, according to instructions.

Instructions in the Electro-Motive operating manual are to reduce the throttle to No. 6 position or below when braking a train. We instruct our enginemen to place the throttle in No. 4 position because No. 5 and No. 6 throttle positions are such that, if any one of the safety brake applications should occur, as a result of getting the engineman's foot off the safety pedal, automatic-train-stop application, over-speed or an emergency brake application, and the engineman did not get his throttle out of these positions immediately, he would kill his engines.

The inception of the Diesel electric locomotive created new and additional problems for the engineman and for the road foreman. The Diesel engine is a radical change from the steam locomotive and, therefore, took considerable study by the supervisors so that they in turn could relay the knowledge acquired to the engineman. Our Diesel instruction car has done a wonderful job in the education of engine crews, whereby they can learn the fundamental principles of the Diesel locomotive and locating trouble when it occurs, as they can actually see in the car a cutaway of all the electrical equipment and how it functions.

Correct operation of Diesel locomotives depends generally on proper instructions being given when qualifying engineers and firemen. The road foremen of engines and the assistant road foremen of engines should be well qualified themselves and be able not only to instruct, but to operate the locomotive to demonstrate if necessary.

You all know that it takes time and patience to convert an engineman who has been brought up with steam locomotives, to Diesel-electric operation. The fireman is a much younger man and he is able to grasp ideas and absorb information more readily. The engineer does not have the opportunity to acquaint himself with the equipment in the engine room at engine-crew changing points, because he has certain duties to perform in the cab that prevents him from checking the engine room.

About all the information the engineman receives is the instruction given him by supervisors and the Diesel instruction car and our Diesel operating manual. Therefore, that is the reason it takes much longer to educate enginemen on the different appliances of the engine-room and trouble-shooting. Firemen today are the enginemen of tomorrow, and I believe that in a five-year period we should have well-educated enginemen who will not only have knowledge of operation, but trouble-shooting as well, because of the experience gained as firemen.

After enginemen and firemen are qualified they may make trip after trip without any difficulty. Then, when something happens, they forget what to do. In starting the new engineman out on a Diesel locomotive, he should be placed in the engineman's seat at the beginning, because a well-qualified supervisor can observe operations and keep an engineman out of trouble by standing next to him, and by this method he gets the feel of the different appliances immediately. He has the opportunity of applying his brakes and releasing them. That gives him the feel of the brake valve standing still. Then, the supervisor can

NEW YORK CENTRAL INSTRUCTS ENGINEMEN IN SEVEN STEPS

Step 1

1—Operating automatic train stop equipment and how to reset.
2—Speed governor control: 65 m.p.h. on freight and 95 m.p.h. on passenger.
3—Safety control feature, dead man's pedal and the cut-out valve.
4—Application valve, brake valves and cocks and engineman's controls.
5—Pneumatic control switch, known as the PC switch, and how to recover.

Step 2

6—Throttle emergency stop button; 5 and 6 positions of throttle.
7—Ground protective relay, where located, and why necessary.
8—Engine overspeed trips.
9—Emergency fuel cutoff valves.
10—How to check lube oil and cooling water for proper running levels and where to apply cooling water.

Step 3

11—Distribution panel.
12—Engine-control instrument panel.
13—Lay-shaft manual control lever.
14—How to start engine and to put it on line, at idle and under load.
15—How to isolate and stop engine.

Step 4

16—Proper operation of throttle.
17—Wheels slipping and wheel-slip light; proper sanding.
18—Application and release of hand brakes.
19—Proper changing of controls, cab to cab on A units and A and B units and proper use of hostler controls on B units.
20—Preparing locomotives to be towed dead in train.

Step 5

21—Throttle positions, indicating pointers and load meters.
22—The proper operation of the fuel supply system and how it is pumped from the tank through filters and injectors and returned to tank. Explain 5-, 60- and 100-lb. sight glass.
23—Low-oil-pressure alarm and causes for same.
24—Hot-engine alarm; automatic shutters.
25—Hot-journal alarm. This was used on our first seven passenger locomotives, but now we use only the stink and smoke bombs.

Step 6

26—Checking engine starting contactors after starting.
27—Checking battery-charging ammeter.
28—Checking control air pressure and why necessary on locomotive.
29—Draining moisture and condensation from the air-brake system and reservoirs.
30—Traction-motor blower fans.

Step 7

31—The proper operation of fan clutches and radiator shutters.
32—The transition indicator and shift lever, and overloading.
33—Dynamic braking, and the warning light and unit selector switch.
34—Air braking with power running through water.
35—Draining the cooling system; normal lube-oil pressures.

explain the throttle, the reverse lever, the control buttons that have to be in or out, the gauges, and different appliances in the locomotive cab that have to be operated.

The New York Central issued a stencil June 30, 1945, which had 35 items to teach engine crews on Diesel passenger and freight locomotives, spacing five items apart to teach at a time. This has proved very successful in instructing because, by taking five items at a time and making sure that the engine crews understand them, it not only qualified the crews for good operation, but for trouble-shooting as well. If crews understand the 35 items listed, they are well-qualified to operate Diesels.

[New York Central operating and trouble-shooting instructions are included in Mr. Fortney's paper.—Editor.]

Discussion

In answer to questions, Mr. Fortney reiterated that the New York Central requires more knowledge of the engineroom on the part of the fireman than it does of the engineman. He said that they instruct firemen out on the line or in the yard, wherever they are called. New firemen are required to make trial trips. It is a hardship on the railroads, he said, that men cannot leave the cab when the locomotive is at work. In addition to the instruction which they can get from Manuals and which can be given while the locomotive is standing still, he said, many new men ride the locomotive on their own time to learn something about what happens while it is in operation.

Diesel-Electric Yard Operation

By M. G. Stewart
Washington Terminal Company

We have 52 miles of track in the Washington Terminal. The maximum curvature is 12 deg. and the maximum turnout is a number eight. Our station consists of two levels—an upper and a lower. The upper level has 20 stub-end tracks. These are used primarily by trains entering and leaving Washington over the Baltimore & Ohio and the Pennsylvania. The lower level consists of 10 tracks, one of which is a stub-end track and the other nine continue through and form the connection to the south. These tracks are used primarily by the Southern, the Chesapeake & Ohio, and the Richmond, Fredericksburg & Potomac. Adjacent to the tracks mentioned there are parallel sidings for mail-handling facilities, Railway Express Agency, storage tracks, and the terminal power house.

The entire property of the Washington Terminal is within the city limits of the District of Columbia, and all of our tracks and buildings are surrounded by government buildings and residential sections. Our station is within three blocks of the Capitol, itself.

We have 130 passenger trains arriving and 130 passenger trains leaving the Terminal daily, these being split up into 53 Pennsylvania trains arriving and 53 leaving; 40 B. & O. trains arriving and 40 leaving; 21 R. F. & P. trains arriving and 21 leaving, and three C. & O. trains arriving and three leaving. These trains have to be broken up on arrival and remade for departure, and many of them are on a fast schedule from the time of arrival to the time of departure. These movements are handled by 60 yard crews—23 working the daylight trick, 19 working the middle trick, and 18 working the midnight trick. One of the main advantages of the yard Diesel-electric locomotives is the elimination of smoke, flyash and noise.

The difference in availability between the Diesel-electric locomotive and the steam locomotive can be attributed to (1) the daily services required to keep the steam engine in operation (going to the water station about three times a day and cleaning the fire and coaling the engine at least once daily) while a Diesel can be operated a whole day with very little attention. (2) The monthly inspections of a steam locomotive generally consume from two to three days, while this takes only about seven hours on a Diesel-electric locomotive. (3) The steam locomotive takes from 30 to 60 days for a general overhaul, while for a Diesel locomotive it takes only from four to five days. (4) Considerably more time is required to clean the steam locomotive than the Diesel locomotive because of the dust, continuous flyash and the ashes from the ashpan.

The introduction of the Diesel locomotive in our switching operations on the Washington Terminal has given us a very clean performance, and eliminates the necessity of continuously wiping the cab appurtenances and the movable parts of the locomotive. Another petty annoyance of enginemen which has been eliminated by the Diesel are the steam leaks which develop in and about the steam locomotive. All this adds to the comfort of the engine crew.

The cleanliness of the Diesel is also very important on the Washington Terminal, as our work is the handling of passenger-train equipment exclusively. The Diesel locomotives are playing an important part in helping to keep this equipment clean and to make it easier to clean, thus cutting down on the operating expenses and personal injuries.

The Diesel can be shut down and left unattended for as long as desired, with practically no expense, while with the steam locomotive, when idle, if the steam pressure is kept up, you have not only the cost of coal and water but the added cost of a watchman's compensation.

We have found on the Terminal that since changing to Diesel operation derailments have been reduced because the Diesel truck is more flexible for rounding curves and going over switches and general track arrangements than the driving wheels of the steam locomotive.

Since changing to Diesel operation we receive fewer complaints from passengers about rough handling, notwithstanding that these trains are transferred from one track to another with many cars in each movement and a portion of our station has tracks which are on an abrupt grade.

There has been continuous discussion among the enginemen relative to the throttling of the Diesel locomotives as compared to the steam locomotives since the Diesels arrived. Men who feel that they did a better job with the steam engine are improving their performance daily in handling the Diesels.

Washington, D. C., is practically at sea level. During the spring and fall seasons the District is frequently covered with fog. This requires vigilance of the highest order. Diesel crews are fortunate in having a complete view of the roadway at all times from their usual positions in the cabs. Yard operation, with the numerous tracks, curves, switches and signal system, demands that the crews be on the alert at all times. The large windows both in the front and rear of the cabs of Diesel locomotives provide a full view of the signal system at all times, even during the most inclement weather. Many hazards have been eliminated because of this one provision—a full and unrestricted view.

Diesel switching locomotives operating on the Washington Terminal are 1,000 hp., have a tractive force of 74,670 lb. Adhesion is 30 per cent. Our heaviest steam locomotives have a tractive force of 76,154 lb. and a factor of adhesion of from 3½ to 4½. The Diesel locomotive has a constant torque at a constant speed which gives a steady pull on the drawbar between the locomotive and the cars. This is important to us as a large per cent of the cars handled at Washington Terminal during shifting movements are occupied by passengers and at times meals are being served in the dining cars.

The controls in the cabs of the Diesel-electric locomotives are readily accessible to the engineman without leaving his seat.

With the introduction of the Diesel locomotive the fire hazards of the American railroads have been greatly reduced. During the past 50 years the claims paid by the railroads for fires

claimed to have been started by steam locomotives to industries, homes, farm buildings, grass and timber land, have run into millions of dollars. It is a fair assumption that many of these claims were based on mere conjecture and inasmuch as the operating heads of the railroads were anxious to avoid publicity and long periods of litigation, settlements were made. Moreover, many of the industries, located adjacent to the railroads, were shippers.

Immediately on delivery of the Diesel-electric locomotives a suitable flange oiler was applied. The flange oiler goes a long way in cutting down the general wear on wheel flanges and rails. On account of the equal distribution of weight on the wheels of the Diesel, the overall track structure is easier to maintain.

Discussion

The questions asked of Mr. Stewart after he had completed the presentation of his paper indicated an interest in three subjects: flat spots on the locomotive wheels, flange oilers, and rough handling in switching passenger trains. In answering questions on the flat spots, Mr. Stewart called attention to the fact that the Washington Terminal deals exclusively with passenger trains. This means that the size of cuts handled in the yard are relatively small and that in many movements, when the cars are occupied, the train brakes are coupled up and are used in controlling the speed of the movements. He said that when the Diesel-electric locomotives were new, they reduced the pressure of the independent brake to 40 lb. per sq. in., but later this was increased to 45 lb. No wheels, he said, have had to be removed from Washington Terminal locomotives on account of flat spots.

The remarks on the subject of flange oilers indicated some dissatisfaction with oil for application to flanges is the effect of changes of outdoor temperature on the viscosity of the oil. If, for instance, an oil of light viscosity is being used because the weather is cold and there is a sudden warm spell, the light oil will thin out and be spread onto the wheel treads. This has led to the development of interest in the use of graphite, but questions brought to light practically no experience with it.

In reply to questions with respect to rough handling of passenger cars on the Washington Terminal with Diesel-electric locomotives, Mr. Stewart said that this was a matter which had to be followed up persistently and that the enginemen were improving steadily. At the beginning of their Diesel experience he said that three special-duty men had been assigned, one on each trick, to watch the performance of the engines closely. These men were kept in service for two years training enginemen and correcting their performance.

Handling Freight Trains with Diesel Locomotives

Good handling depends upon the proper make up of trains and upon the physical characteristics of the track over which the train is operated and on the judgment used in the actual handling of the train. The ideal make-up of trains means all loads or all empties. The next best make-up would be loads and empties equally mixed. The next would be heavy loads ahead of light loads, and last, loads on the head end and empties on the rear. Because of blocking of trains it is not always practical to have trains made up to afford better handling. Therefore, enginemen should know before departing from a terminal or points where consist of train has been changed, the make-up of the train in order that he may use the best method of handling.

Brake Test

When testing brakes, after the brake system on a freight train is charged to not less than 5 lb. below the standard pressure for that train, a 15-lb. service reduction must be made upon request or proper signal, then note the number of pounds of brake-pipe leakage per minute as indicated by the brake-pipe gauge, after which the reduction must be increased to a total of 20 lb. The piston travel on all cars must be between 7 and 9 in., and the brake rigging not fouling. When cars are picked enroute, subsequent to a terminal brake test, brakes should be tested on these cars in accordance with instructions.

Where an excessive brake-pipe gradient exists due to leakage, the initial reduction will produce a fast rate of brake-pipe runaway from the head end causing the brakes to apply more heavily at that location, resulting in undue run-in of slack. For this and other reasons, it is essential to use first service position of the automatic brake valve when making the initial reduction. It is important for good train handling that leakage be reduced to not over 5 lb. per minute.

The handle of the automatic brake valve should not be moved from running to lap position anticipating a brake application. This is an unsafe practice and is liable to cause undesired quick action of train brakes, or if the position of the handle should be forgotten it would be the same as a closed angle cock.

Starting

While starting the train, care must be exercised by observing the ammeter and using only the amperage necessary. With the modified maximum field start that has been incorporated in most E.M.D. governors we are able to do a better job of starting; however, it is possible to apply power so slowly that the train slack is stretched tighter and tighter without the locomotive moving any appreciable distance. The draft gears are now stretched throughout the entire train and the rear end has not moved. To start, it will be necessary to lift the entire train, therefore more power is applied and the weak or 50 per cent broken coupler or weak draft gear gives way and we have a separation. Therefore, it is essential to know where the slack is before attempting to start. If the stop was made by the same engineman, he knows whether the slack is bunched or stretched. On the other hand, if he had nothing to do with the assembling of the train when it was made up or did not make the stop, he has no knowledge of the location of slack and great care must be exercised when starting.

If necessary to take slack, the slack of the entire train should be taken. If on a heavy ascending grade, it is better to apply the train brakes before taking the slack, then release the locomotive brakes and brakes on a few head cars, applying power until the locomotive moves back the distance the slack amounts to which, on the average draft gear, is one car length for each 80 cars. It will then be necessary again to apply the train brakes with a full service application in order to insure a release. Sand should be used sparingly during the backward movement to prevent slipping when starting.

When starting with the head end of the train on a descending grade, care must be exercised to prevent the head end moving at a too rapid rate before the rear end of the train is in motion. The locomotive should be moved slowly until the entire train is moving and the speed should be kept slow, giving trainmen an opportunity to inspect the train and board the caboose safely.

Slow-Downs and Slack Control

To avoid rough handling of freight trains through sags and around curves, with a three-unit, 4,500-hp. Diesel and a train consisting of 70 cars or less, the majority of loads on the head end, drifting of the locomotive is not necessary. It is good safe train handling to pull the train through sags against brake applications in order to keep the train stretched for slack control. When making a slack-control application do not permit the Diesel locomotive brakes to apply during the application. Make no throttle changes if in Run 8 position; if in a lower position, advance the throttle one position during the time the brake valve is exhausting, timing the application so that it is completed as the

Diesel enters the low part of the sag or approaches the entrance to the curve.

If the speed is reduced to where the load meter indicates an increase of 30 to 40 amp. during the brake application, the throttle must be reduced one position until the train brakes have been released, then the throttle can be advanced.

When making a slow down for other causes with a train of 70 cars or less, the throttle should be reduced gradually to Run 4 position and time allowed for slack adjustments, making an initial reduction of 8 lb., using first service position of the brake valve. If time and distance will permit, further reduction of brake-pipe pressure may be made by leaving the brake valve in first service position. If time and distance will not permit, make a split reduction of not over 2 lb. each. During the slow down the Diesel throttle must be reduced one throttle position for each build-up of 30 to 40 amp. on the load meter and the throttle should be in a position where the load meter does not indicate above 200 amp. at the time the brakes are released. Diesel locomotive brakes must not be permitted to apply throughout slow down.

When train consists of more than 70 and less than 100 cars avoid as far as possible the use of the train brakes to make a slow down. Instead, reduce the Diesel throttle sufficiently in advance to meet speed requirements. When necessary to use train brakes to meet speed requirements, the throttle should be gradually reduced to idle, permitting time for slack adjustments, following by an initial reduction of 7 to 8 lb., using first service position. Make no throttle changes, add to the initial reduction light split reductions of not more than 2 lb. each, to further reduce train speed and insure getting a total reduction of 15 lb. Release can be made at a speed of not less than 20 m.p.h. Do not permit the locomotive brakes to apply during the slow down except just before placing the brake valve in position to release the train brakes. The independent brake on the locomotive should be applied to a valve of not less than 20 lb. and held applied until sufficient time is allowed for train brakes to release. Then the brakes on the locomotive must be released in light graduation of not more than 4 lb. each to permit the spring slack to adjust in the draft gears. When slack is adjusted the throttle may then be advanced slowly to meet requirements.

When a train consists of 100 to 140 cars handle as outlined for 70 to 100 cars, except that release of train brakes must not be attempted when speed is below 30 m.p.h. and a total brake-pipe reduction of 20 lb. has been made.

When the speed restriction is less than the minimum speed for release and by releasing train brakes at this speed the train speed cannot be reduced to meet the speed restrictions, the train must be brought to a stop and brakes released before attempting to start.

Stopping Freight Trains

To stop a freight train consisting of 70 cars or less (except one having loads behind empties) and train speed above 15 m.p.h., have the slack all out by using a pulling throttle, make an initial brake-pipe reduction of 8 lb., increasing the throttle one position if in any position below Run 8 and do not permit the locomotive brake to apply. Split reductions of 2 lb. each should be added if necessary. When the brakes become effective and the train speed is reducing, the throttle should be closed to idle, one position at a time, so that it is in idle position at least 100 ft. before stopping, and have service exhaust discharging and locomotive brake applied during the last 40 ft. of the stop. To stop a freight train of 70 cars or less having loads behind empties and trains consisting of more than 70 cars of any make-up, the throttle should be reduced to idle, one position at a time and time permitted for slack adjustment. Then make an initial reduction of 6 lb., keeping the locomotive brake from applying. If necessary, further light split reductions of 2 lb. each may be added. When the train is within 40 ft. of the stopping point, make a final reduction having the service exhaust open and locomotive brakes fully applied as the stop is completed. Stops should be made with a total of not over 12 lb. application when possible.

To stop a freight train with the automatic brake at speeds below 15 m.p.h., the throttle must be reduced to idle position early enough to drift to a very slow speed, allowing time for slack adjustment. Make an initial reduction of 6 lb., giving time for further slack adjustments and if grade and conditions require, further light split reductions may be added, having service exhaust open as stop is completed. Stop should be made with a total reduction in brake-pipe pressure of not more than 10 lb. A further reduction should be made after the train has been stopped in order to insure a release.

Freight trains should generally be stopped with train brakes, but where speed, weight of train, grade, and time will permit, it is permissible to make the stop with the Diesel brake alone. Very little pressure should be used in the brake cylinders on the Diesel until the slack has had time to close against the locomotive. Stop should never be made with the independent brake from speeds above 10 m.p.h. Keep brake cylinder pressure on locomotive at a value that will not cause sliding of wheels.

When a train is stopped on an ascending grade by use of the Diesel brake, the cylinder pressure must be reduced as speed reduces and the brake released and power used to stretch the train gently before coming to a stop. If handled differently, the compressed draft-gear springs will start the train moving back, producing rough slack action. If the train starts to move back, do not attempt to stop it quickly with either the automatic or independent brake. Stop with a light application of the train brakes.

When working power at slow speed do not close the throttle suddenly and follow quickly with a brake application, unless some impending danger is great enough to warrant risk of severe slack action that may do serious damage. If time will permit, move throttle to idle position, one position at a time, and give time for the slack to close gradually, then stop by applying the train brakes 40 ft. in advance of the stop or by use of locomotive brake only.

When stopping a freight train while moving back at slow speed, make a light application of train brakes, keep locomotive brake from applying and work power to within a few feet of stop. Do not make a final reduction.

Emergency Stops

When necessary to make an emergency stop application, move the automatic brake-valve handle to emergency position and leave it there until the train stops. Close the throttle to idle position after the brakes are applied and start sand.

In case of emergency action of train brakes caused by other than the handling of the engineman, move the automatic brake valve to lap position and leave it there until the train stops. Close the throttle to idle position and do not allow the brake cylinder pressure on locomotive to build up to a value that will cause sliding of the wheels.

When train brakes apply suddenly with a rapid drop in brake pipe pressure, the engineman should depress the handle of the independent brake valve to keep the locomotive brake from applying, move the automatic brake valve to lap position, and close the throttle rapidly to idle position and when train is within 40 ft. of stopping apply the independent brake full value and, if conditions require, have sand flowing the last locomotive length. After the train stops, wait one minute for the vent valve on the control valves to close, then move the automatic brake valve handle to running or release position to permit air flow into the brake pipe to enable trainmen to locate the trouble and for resetting the P. C. switch on the Diesel locomotive.

When the engineman observes the train speed is being reduced more than it should be due to grade and other operating conditions, or observes the amperage on the load meter increasing or, on a Diesel equipped with flow-meter, the flow-meter signal light burning, this indicates train brakes have been applied by the conductor's valve or by bad brake-pipe leakage. When this occurs, gradually close the throttle to idle position, one position at a time, leave the automatic brake-valve handle in running position, and when the train is within 40 ft. of stopping, apply the independent brake full value. After stopping, a full service brake application must be made before proceeding.

When a train is stopped under the above conditions and the caboose and Diesel locomotive are not equipped with radio communication, the conductor must know that brake-pipe pressure as indicated by the caboose gauge is being restored before giving a signal to proceed.

In formulating this paper, no attempt has been made to cover brake operation on heavy grade territory.

The length of time necessary to stand before attempting to start to allow for all brakes to release after the stop has been made with train brakes, has been omitted as tests have indicated this time interval varies and can usually be worked out on the individual roads.

The report was signed by F. T. McClure, general supervisor air brakes, A. T. & S. F. (chairman), and R. H. Francis, general road foreman of equipment, St. L.-S. F.

Discussion

The effect of the make-up of the train on the braking was the subject of particular interest in the discussion. Mr. Francis said that it was impossible to stretch freight trains of 125 cars or more. With a 5-lb. brake-pipe pressure gradient between the ends of the train a 15-lb. reduction on the head end will mean a 10-lb. reduction on the rear end, which is equivalent to 34-lb. cylinder pressure at the head end and only 17-lb. on the rear end. Asked why he used 8-lb. initial brake-pipe reduction rather than 6-lb., he said that less than 8-lb. produced a uniform cylinder pressure both in the AB and Type K brakes, whereas a smaller reduction tended to develop a higher pressure in the AB cylinders than in the K cylinders. W. E. Vergan, Missouri-Kansas-Texas, pointed out that there are just two ways of braking a train, one with the slack in and the other with the slack out. If the slack is out, it must be kept out and not allowed to run in and then out again. If the train is made up so that the pulling throttle cannot be used, then use a drifting throttle and apply the locomotive brake with the train brake and keep the slack in.

Controlling Trains with the Dynamic Brake

By P. A. Quarles

Atchison, Topeka & Santa Fe

Our first experience with the dynamic brake was the two-stage, which had two operating positions, B-1 and B-2, on the controller. With this brake it was necessary to reduce the speed by use of the air brake to a definite point before application of the dynamic brake. While this type of brake proved very economical in mountain territory where it was necessary to operate and control trains at reduced speed for a considerable distance, its characteristics were such that it was of little value in level grade territory.

A multistage brake suitable for all operating grade conditions and with an operating speed range of 10 to 60 m.p.h. in freight service (100 m.p.h. in passenger service) was developed. The first brake of this type applied to a Santa Fe locomotive was on a 5,400-hp. freight Diesel locomotive placed in service in March, 1942, and it has been applied on all locomotives delivered since, both freight and passenger.

As a result of experience gained in the use of the dynamic brake in heavy grade territory the Santa Fe undertook to extend its use to all territories. A series of test runs were made on the El Capitan, a lightweight, streamline, all-coach train between Chicago and Los Angeles, operating on a 30-hr. 45-min. schedule for the 2,227-mile run. The dynamometer car was used to record data, from which braking information could be developed, as to the practical use of the dynamic brake in both freight and passenger service on all territories. Two types of test runs were made in passenger service, one using 150 per cent braking ratio without high-speed governor control, and the other with 250 per cent braking ratio with high-speed governor control. Five round trips were made in each series using air brakes only and five round trips using the dynamic brake everywhere possible, supplementing with air brakes when necessary. The test train consisted of an F-3 class Electro-Motive four-unit Diesel locomotive, the dynamometer car, and 13 cars, including mail, club, lounge, dining and chair cars. The Diesel locomotive was equipped with the 24-RL brake equipment, multistage dynamic brake and dynamic-brake interlock; the dynamometer car with LM and all other cars with D-22 control equipment.

During the test runs of approximately 93,000 miles, particular attention was given to the handling of the train for smoothness of operation. In general there were very few occasions of rough handling or shock due to slack action caused by the use of the dynamic brake, and with more experience our enginemen have improved in their handling of the dynamic brake to the extent that we do not now experience as much shock with it as we did during the test trips.

Instructions that have been issued to our enginemen, covering method of using dynamic brake for controlling speed of passenger and freight trains provide that the dynamic brake alone must be used in reducing and controlling train speed, if time and other conditions permit, make provisions and outline methods for handling dynamic brake and train brakes in conjunction with each other when conditions are not favorable for controlling train speed with dynamic brake alone.

It was observed on our test trips that, when operating with dynamic brake fully applied, slack bunched, registering a buff on dynamometer car, and when a brake-pipe reduction of 7 to 10 lb. was made the train slack would stretch and change from a buff to a pull. Likewise, when the throttle was reduced to idle position and a 7- to 10-lb. brake-pipe reduction was made and the locomotive brake not permitted to apply, and then as the brake-valve service exhaust closed, the transition lever was placed in braking position and gradually moved to maximum braking, the slack did not change but continued to register a drawbar pull throughout the entire brake application. These observations were made when handling the test train with cars equipped with D-22 control equipment. The same conditions prevailed on long trains with LN and UC equipment when a 10- to 12-lb. reduction was made in brake-pipe pressure.

The number of units used to make up the locomotive, and the number of cars and kind of brake equipment will govern the amount of reduction in brake-pipe pressure necessary to stretch slack when using the dynamic brake to its maximum. In freight service, the number of empties and loads, how heavily loaded, and location of loads in train governs slack action when using dynamic brake and air brakes in conjunction with each other.

When operating freight trains on comparatively light grade territory where the minimum amount of retardation is required to control train speed, we have found it to be in the interest of good handling, to apply the dynamic brake sufficiently in advance of the restriction that train speed may be reduced as desired without using the air brakes. When the train brakes are applied after train slack has been bunched by use of the dynamic brake on long trains on light grade territory, it is as a rule in the interest of good handling to complete the stop before releasing train brakes. To do this consumes more time and causes more delay than the time consumed by starting farther back and using the dynamic brake alone.

A large number of our supervisors and enginemen were of the opinion that it is impractical and perhaps impossible to make use of the dynamic brake for controlling train speed on level territory. Some felt it was necessary to leave the throttle in Run 8 until the initial reduction was made to avoid slack action and many were skeptical about rounding curves with passenger trains without holding train brakes applied around the entire curve, notwithstanding that instructions of long standing provided for train brakes to be graduated or released as the train entered the curve. Their experience and observations of the

riding qualities of the train on courves when speed had been reduced with the dynamic brake alone was to find that the train moved around the curve smoother than it did when the train brakes were held applied on the curve.

The most popular argument against the use of dynamic brake is the claim that too much time is lost when using this brake. It is understood a train can be stopped in less time and distance by use of train brakes than it can by use of the dynamic brake alone. Some enginemen will use more time in making a slow-down or stop than others, regardless of the method of braking or equipment used. The same holds true when using the dynamic brake. During our test trips on the El Capitan, on one run we operated from La Junta, Colorado, to Chicago, a distance of over 1,550 miles, and the train brakes were used only twice to assist in reducing train speed. We left La Junta a few minutes late, were on time into Newton, Kansas; delayed at Newton a few minutes over dead time servicing the train; into Kansas City on time, departed Kansas City 22 min. late and arrived at Chicago on time. After reducing train speed to 20 or 30 m.p.h. with the dynamic brake alone, the station stops were completed with train and locomotive air brakes. The two air-brake applications were occasioned by unexpected restrictive signal indications.

On this trip we used 69 min. from La Junta to Syracuse, Kansas, a distance of 101 miles, during which time we reduced speed with the dynamic brake alone to comply with speed restrictions of 95 m.p.h. on 12 different curves, to 90 m.p.h. on three curves, to 80 m.p.h. on two curves, 70 m.p.h. on three connected curves and one slow-down, and to 65 m.p.h. through Syracuse. Most of our enginemen and a number of supervisors found that we could expand the use of the dynamic brake. Enginemen in mountain-grade territory, who were the strongest supporters of the dynamic brake, found they could use this brake to advantage under conditions where they had not been using it.

One way of performing better service at less cost is to reduce our brake-shoe and wheel wear by use of the dynamic brake, which offers positive relief from these conditions, and, if used conscientiously by the enginemen, it will reduce the number of thermal cracked wheels. Prior to our test trips on the El Capitan, we were applying new brake shoes throughout the entire train each trip into Los Angeles, experiencing some delay enroute renewing brake-burned shoes, and on arrival at Chicago replacing all shoes that were worn to 1½ in. thickness at the thinnest point. Since we have placed our dynamic braking program into effect, we have discontinued renewing brake shoes at Los Angeles or replacing at Chicago, unless worn to 1 in. in thickness at the thinnest point and seldom do we experience a delay enroute renewing brake-burned shoes.

Abuse of Diesel Locomotives

In starting the engine, if it has been standing long enough to have become cold, the cylinder test cock should be opened and the engine turned over a few times with the lay shaft held closed, in order to relieve the cylinders of any accumulation of water that may be inside them.

The fuel pump should be started far enough in advance to insure that fuel is circulating through the entire system before the engine is started. This only requires a few seconds, and allowing it to run unnecessarily long could result in bad effects. There is always a possibility of dribbling injectors that may leak fuel into the cylinders. Raw fuel in the combustion chambers could result in those cylinders firing prematurely, which could cause cracked cylinder heads, broken valves or cracked pistons. If enough fuel oil leaks into the cylinder it could destroy lubrication and cause scored pistons and liners.

The engine won't run with the over-speed trip tripped, and with the lay shaft stuck in closed position. We have had the batteries completely exhausted before it was discovered that these conditions existed. To crank the engine the start button should be pressed in and held firmly until the engine starts. The engine should fire within 10 seconds. Closing and releasing the starter switch repeatedly causes arcs that heat and warp the contactors and cause them to make poor connections, which will cause them to burn and cause the contactors to stick each time they are used.

Any attempt to start two engines from the same battery circuit at the same time will result in a blown starting fuse. After an engine has been started it should not be left until the oil pressures have built up to at least the minimum, and the isolation switch has been placed in run position. The benefit of the low-oil-pressure alarms are not had on certain type Diesels unless the isolation switch is in run position.

The water level should always be rechecked after the engine has been running a short while, as there is always a possibility of air locks in the cooling system, especially if it has been drained and refilled. The engine should not be placed in service or even expected to respond to throttle position until the temperature is at least 125 deg. F. Cold oil does not flow as freely as warm or hot oil. When coupling onto train on which the air-brake system has not been charged, it may be desirable to increase the speed of engines in order to hasten the charging of the equipment. This should not be done in above throttle position 3. The brake-pipe charging rate is no faster when main-reservoir pressure is raised above 110-lb. (with brake-pipe feed valve set at 80-lb.) than at 110-lb.

To avoid abusing a Diesel engine the engineman should be well informed as to the tractive force of the locomotive, especially at the lower speeds. Much damage has occurred by hurrying out with the throttle instead of coming out gradually, giving the governors ample time to speed up and load the engines properly. Knowing that transition has taken place on all units at the proper time is very essential. To run a unit in a locomotive in series at high speed while other units are in parallel will result in damage. The same is true if some unit remained in parallel while others were in series at the lower speeds.

Improper handling of the throttle in starting trains constitutes abuse. The engineman should know where the slack is especially when handling full tonnage and starting from difficult locations. To build the amperage up to the maximum and permit the locomotive to stand for several seconds before starting is wrong and certainly does the commutators no good. To "slack stretch" even a light train at a difficult location may result in having to take the slack all over again.

Most governors have been supplied with what is known as the modified maximum-field-start load-regulator pilot-valve sleeve. When the throttle is reduced after the load regulator has been in maximum field it will remain in this position, and the engineman must allow a few seconds in No. 1 position to permit the engine speed to reduce before closing the throttle. This is to prevent heavy arcing at the power contactors. At such times the locomotive brake must be set full to prevent a heavy surge from the draft gears when the throttle is finally closed.

Transition may be made too suddenly by not giving time for the engine speed to change after reducing the throttle. Using sand excessively is abuse and to catch a locomotive on sand while slipping is still worse.

We know of instances where enginemen attempt to hold the speed of a train of 4,000 tons on a one per cent descending grade with the locomotive brake over a slow order for a distance of one mile. The result, nine-inch flat spots on wheels that became locked. He had no wheel-slip indication because he had his throttle in idling position.

We also know of instances where emergency action was propagated throughout the train by a broken train line at slow speed and, before engineman took action to prevent brake-cylinder pressure building up so high that all wheels skidded, the damage had occurred.

Fanning the independent brake valve is not an unusual occurrence and if once explained to the engineman that instead of

taking advantage of the self-lapping brake valve (on a 3-unit locomotive) he is filling and emptying 24 brake cylinders each time he does so, he, no doubt, would refrain as this is a waste of air. To give long service the compressors should remain unloaded at least 60 per cent of the time. Fanning the throttle is just as bad.

Enginemen have been observed attempting to start a train and discovering that they had forgotten to close the generator field switch, then reaching up and closing it before giving time for engine's speed to reduce and the load regulator to get out of maximum field. An engineman very seldom repeats this action.

By reducing the throttle to No. 3 at railroad crossings just before the front truck arrives at the crossing, the load regulator will actually be lower than later when it has time to readjust itself to the new position.

[The remainder of the report dealt with the electrical equipment and referred to maintenance more than to road operation and attention.—Editor.]

The members of the committee which prepared the report were R. D. Nicholson (chairman), road foreman equipment, New York, New Haven & Hartford, and R. H. Francis, general road foreman of equipment, St. Louis-San Francisco.

Braking High-Speed Passenger Trains

By R. G. Webb

Superintendent air brakes, Chicago, Milwaukee, St. Paul & Pacific

Those responsible for operating trains do not intentionally cause rough handling or lose time in making slow downs and station stops. That such undesired results can be avoided as a rule is proved by the service rendered by many enginemen. Many times the engineman does not have the information that a poor stop was made at Station X, and at Station Y the stop was perfect. He seldom knows of these results unless damage occurs.

While we are talking about the engineman, we must not lose sight of the condition of the equipment that he is handling, or of the ability of the man responsible for the train handling. It is our duty as supervisors to educate these men and have them familiar with the equipment and the proper method of handling it. A good job cannot be done unless the air compressor, the brake valve, the feed valve and the compressor governor are in good condition. Are the standard air pressures being maintained? Is the feed valve maintaining the brake-pipe pressure? Does it respond to slight variations in brake-pipe pressures? Does the brake valve handle freely, or is it necessary for the engineer to use both hands to get it into service position after it has not been used for some time? All of these are most important in smooth train handling. Nor must we forget for a minute the car, the couplers, the brake-pipe leakage, the piston travel, the type of brake equipment, together with its general maintenance. All of these help to make the task of smooth handling easier.

Damage to wheels generally comes from two sources, overheating and sliding. Both of these types of damage can be caused by stuck brakes, and stuck brakes result from improper braking or equipment not maintained in proper condition. Wheels can also become overheated because of excessive braking, especially on long descending grades. This results from either too much braking on the entire train over extended period, or too much braking on part of the train which is carrying more than its share of braking effort due to improperly maintained equipment, or to brake manipulations that tend to overload sections of the train.

With the additional streamline, light weight, high speed trains placed in service each year the effect upon safety of operation at the high rate of speed at which some of these trains operate, many reaching 100 M.P.H., is a matter which requires serious consideration. To permit the operation of high-speed trains with safety, signal systems have been adjusted not only to provide adequate stopping distances but also to provide adequate warnings at grade crossings. The security of the track structures has been improved. In order that passenger trains carrying out these schedules be stopped quicker, many innovations of the brake equipment have been developed, such as the D-22 control valve, speed governor and electro-pneumatic braking, together with the tight-lock coupler, which helps to prevent slack action.

Initial Terminal

If the train is to be operated pneumatically, a brake test made in the usual manner must be given before the train leaves the initial station. If the operation is to be electro-pneumatic, then after the brakes are tested pneumatically they must be tested electro-pneumatically. In both instances an employe must walk the length of the train to observe whether the brakes have applied and released with both tests. During the pneumatic operation the engineman should observe the air gauge to determine whether the brake-pipe leakage is more than 5 lb. per minute.

Starting Trains

It matters little whether the train is handled by a steam locomotive or a Diesel locomotive, the slack should be stretched gently and the train started slowly in order to prevent shock. If at a point where the power wheels are liable to slip sand should be used. Slipping of wheels with a steam locomotive invariably results in a change of slack, consequently causing shock in the train, therefore, sand should be used to prevent drivers from slipping and not to stop slipping after it occurs. If slipping occurs on a Diesel locomotive, throttle should be reduced until slipping stops and then sand used to prevent further slipping as the train is being accelerated. Furthermore, excessive slipping of Diesel power wheels is liable to cause damage to the traction motors or kick out the overspeed control.

Slow Downs

When making slow downs the best results can be obtained by reducing the throttle on both steam and Diesel locomotives as the brake comes on. With the steam locomotive reduce the throttle partly, depending upon the amount being used. With a Diesel locomotive running in the eighth notch, reduce the throttle to about the third or fourth notch. With a steam locomotive it is well to reduce the engine brake on the initial application. With a Diesel locomotive, except when handling mixed equipment, allow the brake to come on with the train brake.

On streamline, high speed trains it is a mistake to release the locomotive brake when making slow downs or stops. Often the locomotive weighs one-quarter to one-third as much as the train. If the locomotive brake is not used, the car brake has to do the work of the locomotive. Time in making the stop or slow down is lost, and car brake shoes and wheels are often damaged.

On trains of mixed equipment, such as mail, express, etc., it is well to release partially the initial application on the locomotive in order to prevent bunching the slack. It is good train handling to prevent exchanges of slack during braking. If the brake is applied with the slack stretched, graduations and releases should be made with the slack stretched. If the slack is bunched when the brake is applied, graduations and releases should be made with the slack bunched. By manipulation of the engine brake and the throttle the engineman can do a lot to prevent exchanges of slack. Re-applications following graduation or release in which sufficient time has not elapsed for the pressure to be restored are the most critical times in which exchanges of slack are liable to occur. In these instances the second reduction should be 6 or 8 lb., followed by whatever is necessary to complete the slow down or stop.

When Split Reductions?

If running 50 m.p.h. mixed equipment, such as LN, AB, UC,

D-22, and the train is close enough to stopping point to require an 18 or 20 lb. brake pipe reduction, I would recommend it be split, make 8 or 10 lb. reduction initially and follow with an 8 or 12 and reduce the throttle after the brake comes on. If running 80, 90, or 100 m.p.h., I question if it is necessary to split the reduction unless the train is long and on a grade.

With mixed equipment, such as the above, we know that it requires 20 to 22 seconds to develop full brake-cylinder pressure on the rear car of a 12- or 14-car train. At 90 m.p.h. the speed is 132 ft. per sec. and the travel is 2,640 to 2,904 ft. before maximum brake cylinder pressure is obtained. With the D-22 control valve this time is somewhat shortened. If braking electro-pneumatically with modern equipment and running 80, 90 or 100 m.p.h., move the brake valve into the application zone far enough to energize the magnet valves and bring the shoes up against the wheels. As soon as this occurs move the brake valve into the application zone far enough to develop the brake cylinder pressure necessary to make the stop. In other words, use three or four seconds in getting the electro-pneumatic brake on. If braking pneumatically or electro-pneumatically at speeds of 80, 90 or 100 m.p.h., streamline equipment, D-22 control valve, make the 20 or 22 lb. brake pipe reduction continuous. As the speed comes down remember at 35 or 40 m.p.h. with high brake-cylinder pressure we need to make a graduation providing the train is not equipped with speed governors. Move the automatic brake valve toward running position releasing the desired brake-cylinder pressure. Do not "fan" the brake valve as street car motor men do and as some enginemen do with the independent brake. It is self-lapping; move it to the desired position and leave it there. To "fan" the brake valve causes severe exchanges of slack.

A good train handling engineer does not start braking a couple of miles before the station is reached; neither does he wait until near the station platform before setting the brake. In other words, you should not make long drawn out stops or slow downs, neither should you make short, snappy stops or slow downs. Both are hard on shoes and wheels. A happy medium should be reached. In stopping make at least two graduations, stopping with a small amount of air in the brake cylinders to prevent rolling.

Co-ordination in Control of Railroad Smoke

By H. C. Ballman,
Smoke Regulation Engineer, Columbus, Ohio

The railroads as an industry, in isolated cases, have taken a very active part in smoke programs. However, it was not until recent years that any action was taken by them which would in a sense unify their total effort so that active smoke regulation could be a reality in all cities rather than in a scattered few. The first concerted action by the industry that came to my attention was in the setting up of a sub-committee for railroads by the Coal Producers Committee for Smoke Abatement. The coal producers have of necessity taken an active interest in all air-pollution and smoke regulatory programs all over the country. Their appointment of a railroad sub-committee made up of members of a number of the leading railroads in this country was a first major step in an actively coordinated program to regulate smoke.

This particular group had a very difficult task of a two-fold nature immediately before it. First in importance they had to sell their own industry and their own railroad companies that the job should be done and that it would be beneficial to the public relations of the railroads to do a good job in smoke regulation. The second and almost equally difficult job was to sell a rather skeptical group of city smoke inspectors that the job could be done, and further, that the railroads would be able to take a leading part.

Late in 1948 The Coal Producers Committee for Smoke Abatement felt it necessary to prove to those who had strong doubts that an industry could lead a civic enterprise such as smoke regulation, and to set up a test program in a representative city. The City of Columbus, Ohio, was chosen as the city for a "Model City Program." Columbus was chosen because it is an average American city, 373,000 population, very centrally located and thoroughly representative of a large number of municipalities demanding smoke control, which range in size from one-quarter to one-half million people. It is also a very active convention city. Many strangers are visiting the city continuously and the work done here would come to the notice of many. It is also a very active railroad center. It is the crossroads for practically all north, south and east and west railroad traffic.

The Columbus Situation

We have in Columbus possibly three to four hundred dispatchments of locomotives daily, originating from a very centrally located depot and some six roundhouses; we have in and around Columbus more than 100 miles of trackage (exclusive of multiple tracks) that our men have to cover daily in their observations; we have up-grades of considerable degree in three directions out of our city; the only direction in which there is any downgrade is to the south. Railroad activity is concentrated very close to the center of the city; about 85 per cent lies within a two-mile circle of the center of the town; and four of the five railroads meet on multiple crossings right in the heart of the city. Very little smoke is made in the city of Columbus by railroad locomotives that can possibly go unnoticed because of the close proximity of residences to the railroad right of ways. In addition the railroads also run on relatively high ground throughout the city making them evident whenever they are making smoke.

This model city program gave the railroads an excellent opportunity to show what could be done if they would get behind the program 100 per cent. The program was an effort to evaluate what could be done when the railroads set their minds to doing a good smoke control job or, if the job could not be done, to determine what were the causes of possible failures and what could be done to eliminate them.

The city already had a smoke regulation program. It took very little effort on the city's part to coordinate directly with the railroads, particularly when they showed this interest. Men were appointed to administer the model program, both for stationary plants and railroads, and it was agreed that one or two men would be sufficient to work with the railroads. Some may raise their eyebrows. Not long ago, and even today, we hear: "The smoke inspector should get out in the yards and on the engines to determine what is wrong, penalize the men or, in some cases, order an engine out of service." In order to do just this we would need at least 300 men so as to follow each dispatchment and crew. We have never believed in this type of administration.

Railroad Problems are for Railroad Men

In Columbus it is our every-day practice to submit railroad smoke problems to railroad men for their solution. When the railroads accept this challenge, as they have for the most part in Columbus, then every engineman, every fireman, road foreman, assistant road foreman, roundhouse foreman, etc., has become a smoke inspector and has become part of our program. This is the way it should be. The basic job of the smoke inspector, as we see it, should be to set up an over-all program for the railroads, indicating whether or not progress is being made by them in the reduction of the emission of dense smoke; pointing out weak places where supervision or operation could be bolstered; laying out educational programs not only for the operators but

for management and supervision as well; and above all, continually to furnish incentive which will keep the program rolling in the fixed direction of better conditions for a given city at all times.

The Columbus program has been set up on the basic premise that the railroad companies are responsible for the right-of-way, and trackage, the rolling stock and equipment, all operating, transportation, and mechanical personnel, all orders and instructions issued to this personnel, and above all they are responsible for the acts or failures of any of these several integrated parts. This basic premise for the program was early expressed to the various railroad companies, and as expected there was originally some doubt, indifference and maybe distrust by the railroads for a program that would try to blame them for everything that might happen. One of the first steps that we took was to appoint to the job of railroad smoke inspector a railroader of considerable experience in and about the city of Columbus, who knew operation well. This appointment of a railroader to the program was a first step in bolstering the confidence of those with whom we were dealing.

In the smoke regulation program the first coordination had to be accomplished within each railroad company before it could make an effort to coordinate its unified activity with the city smoke inspector. Top management was probably the hardest to convince. By top management, I mean those with the authority to issue orders, to approve the expenditure of monies, and generally, the people who run the railroad. In many cases this type of management is far removed from the general activity of a railroad in a city like Columbus. Top management cannot instigate local smoke regulation programs or personally supervise them, but it can and should back up completely the supervision in the local areas where smoke programs are in force. This complete backing should be passed from those in authority to local supervision and to the operators in the field. The fellows in the field or the operators are the key men to have the proper mental attitude in the job of regulating smoke. Only when all others above them in the line of authority have the proper attitude towards smoke regulation will they attempt to assume the proper attitude.

Co-ordination Between Departments

This proper attitude goes so far as to include the full coordination of all interdepartmental activities. In smoke regulation one of the first things that must be stopped on the railroad is "buck-passing." Many of you no doubt have experienced the "passing of the buck" on a smoke violation. The mechanical department insists that the trouble is all on the left hand side of the cab (the fireman). The road foreman in order to justly protect his men then makes the claim that engines are fixed in the roundhouse with pencils. A smoke regulation problem needs the overlapping work and authority of all departments to get the job done. There is no fixed rule how this coordination within companies can be accomplished; it is an administration problem.

All railroads have in their operating rules a statement pertaining to dense smoke, and in every case it is against the company rules to make dense smoke. It is always amazing to me that this universality of thought pertaining to the emission of dense smoke in the rulebook is not just as universal in its application. Few, if any, of the railroads enforce it until a poor city smoke inspector asks them to please meet the city ordinance.

One of the exceptions to this statement was the experience I had as smoke regulation engineer in the city of Richmond, Va. When I arrived in the city as the first administrator of their new ordinance, imagine my surprise to find an active coordinated railroad program already under way and sponsored by the railroads themselves. A group of railroad representatives from all the roads in Richmond had formed a committee not only to help the city write its ordinance, but to start its enforcement on a company rule basis. Never before or since have I seen a railroad group take over so completely their own problem. This may be one of the reasons that the railroad public relations are at a higher level in Richmond, Virginia, than some other cities.

Mutual Confidence

If the railroad coordinates its activity and in so doing applies its own rule against dense smoke and enforces it, we believe it is then ready to coordinate its smoke regulating activities with the city smoke inspector. Confidence in each other will then be established and both will approach the problem on a common ground of agreement that dense smoke is unnecessary. Company men and city men can discuss their mutual problems and work to eliminate the nuisance caused by these problems. The mental attitude as a company will be completely reversed from one of distrust and resistance to one of confidence and acceptance.

In many cases, such as in Columbus, roundhouse and road foremen committees are set up as sub-committees of the superintendents' committee to work directly with the city smoke inspector on common problems. This roundhouse and road foremen committee has the full authority of the superintendents' committee and in practically all cases recommendations made by this sub-committee to the parent superintendents' committee are followed. In addition to working with the city smoke inspector this committee is an excellent place for the railroads to help each other on their common problems.

Basic improvement is immediately noted in the supervision of the railroad when its management accepts the full responsibility for a smoke regulation program. It brings supervision up on its toes. We have found that smoke regulation, properly supervised, leads to better safety records, particularly around the roundhouses; visibility is better in these areas.

The Smoke Inspector Helps the Railroad

Of greatest importance to the railroads is the matter of public relations, and publicity of any sort originating from the smoke inspector's office should be of a positive nature wherever possible. Positive public relations do not mean hiding the facts, but rather reporting the facts in such a manner that they reflect the effort where a railroad is trying to do a good job. To my best knowledge the railroads in the city of Columbus have not had any adverse publicity since the inception of the program in January, 1949.

Wherever possible we believe that the smoke inspector should serve the railroads in working with them to point out specific problems. In this manner we have made city-wide surveys for several days in order to point out the areas in which we find many violations. By so doing and reporting this information to the various railroads we have been able over a period of a couple of months to reduce to one-half the number of violations in some of the worst areas. We also work directly with the railroads on spot surveys to try to help them analyze the conditions which are causing a high rate of violations in a particular area. We do not determine the causes; we merely survey the area and report what we see. It is the railroad's job to work out the necessary corrective measures.

The Present Status

There is still railroad smoke in Columbus. There are violations about every day that our inspectors are out, so we do not wish to leave with you a false sense that the job is finished. Originally, however, it was a very easy matter to remain in one spot and cite 14 to 20 violations in a period of a couple of hours. Today, our men find it difficult to get more than a single violation or possibly two in a whole day's activity, and these are usually found to be caused by circumstances which are abnormal. We feel we are well on the way to the solution of the total job because the mental attitude of the railroads is right, and certainly smoke control itself will follow in due course if the mental attitude and approach is correct.

Some of the basic problems still facing us today are (1) the high rate of re-hire and cut-backs of operating and other personnel; (2) working agreements with men on the railroads oftimes slow down our effort in seeking broader educational programs for them; (3) education with the proper incentive has to be broadened beyond the operator to include personnel from the very top of management to the last man on the roster so that all railroaders may have a clear concept of what can be accomplished not only for the city but the railroad as well.

Discussion

The discussion was largely questions concerning the operation of the Columbus smoke-control program, most of which were

answered by Mr. Ballman. He said that August, 1950, is the first month that could be compared with the same month of the previous year. About 2,500 observations are made per month. Last year operating violations ran at the rate of more than eight per hundred observations. This year they were down to 3.96. From four per hundred observations a year ago, enginehouse violations were reduced to under one. E. Benton, director of research, Ohio Coal Association, emphasized the fact that the industries which have to conform to it wrote the ordinance and that it is being reasonably enforced. He warned that anyone who visited Columbus looking for a smokeless town would be disappointed. There is still smoke, but the accomplishment is measured by the tremendous reduction already effected.

Mr. Ballman said that taking cases to court has been reserved as a last resort, but in some cases they have had to go to court. In the first place, as the result of a number of cases which were thrown out of court, the ordinance was tightened up so that it now stands up under court proceedings. The result of reasonable enforcement has won the co-operation of the railroads, some of which have appointed their own smoke inspectors. When individual firemen become persistent violators of the ordinance court action is taken and the company pays the fine. This practice was questioned by some railway representatives who felt that the individual violator should be fined. Mr. Ballman's reply was "your employees are your responsibility, not mine."

Mr. Ballman emphasized the fact that a smoke regulation program has to deal, first, with the violator and, second, with the local population who want clean air. In dealing with the public, from which complaints come, he advocates making clear to them that when smoke is corrected, there may be more cinders, and that, if they become completely free from the effect of smoke and cinders from the steam locomotive, they must accept the odor and smudge of the Diesel.

Following the discussion, a moving picture was presented which was developed under the leadership of Mr. Raymond of the New York Central and Mr. Benton, which was used in connection with the Columbus program to demonstrate to the railway managements how the job could be done.

Coal Characteristics and Performance of Road Locomotives

By E. D. Benton

Director, Division of Research and Fuel Engineering,
Ohio Coal Association

Some time ago, Bituminous Coal Research, Inc., at the suggestion of the Motive Power Committee, asked Battelle Memorial Institute to collect test data from several sources in an attempt to evaluate in terms of performance and capacity the various characteristics of coal. The writer was in charge of this work, and the data presented here is largely taken from a report to Bituminous Coal Research, Inc.

The only fuel performance test data available which provided accurate comparative results were from the standing test plant of the New York Central System at Selkirk, N. Y. The primary advantage of these tests is that after acceptable locomotive proportions are established by preliminary trials, they remain unchanged during and between tests. Thus, in these fuel-performance tests, the only variable was the coal; and the necessity of attempting to evaluate other variables was eliminated. The data were made available through the courtesy of P. W. Kiefer, chief engineer, equipment, New York Central System. The test procedure was developed by W. F. Collins, engineer of tests; the tests were conducted by M. S. Riegel, assistant engineer, tests, and T. R. Fredriks, dynamometer engineer. Special mention is made of the valuable assistance given by A. A. Raymond, superintendent, fuel and locomotive performance, for his suggestions in the presentation of the data.

Tests were conducted at firing rates of approximately 4,000, 7,000, 10,000 and 13,000 lb. per hour. As the grate area was 82 sq. ft., the rate of firing ranged from 60 to 160 lb. of coal per sq. ft. of grate area per hour.*

A decrease in the excess air with an increase in the rate of output is normal for a locomotive, because the entrainment ratio of the nozzle decreases with increase of rate of flow of steam.

The flue-gas temperatures measured in the smokebox during these tests ranged from about 550 deg. F. at the lower outputs to an average of about 675 deg. F. at maximum outputs. These are typical for a locomotive. The small increase in temperature, despite the fact that approximately three times more flue gas was handled at firing rates above 10,000 lb. per hour than at low rates, demonstrates the efficiency of the boiler in heat absorption.

The boiler absorption efficiency is nearly constant and, for usual cases, is between 82 and 84 per cent. As the flue-gas exit temperature is lower than that of the superheated steam, there is little possibility for improvement in the heat transfer.

The only apparent possibility for increasing the over-all boiler efficiency is to improve the combustion efficiency which was shown in these tests to be definitely related to the unburned-coal losses. Unlike other losses, which remain nearly constant or decrease with increasing output, the unburned-fuel loss increases as the output increases, while its magnitude depends on the size consist and the friability of the coal.

The illustration shows this by presenting the unburned-fuel losses incurred at three typical firing rates with a group of 4-in. by 2-in. and run-of-mine fuels used in the performance tests. The increase in unburned-fuel loss with increased output is caused by the increased gas velocity through the grate, fuel bed, and firebox, which causes relatively large unburned fuel particles to be carried in the gas stream and out the stack.

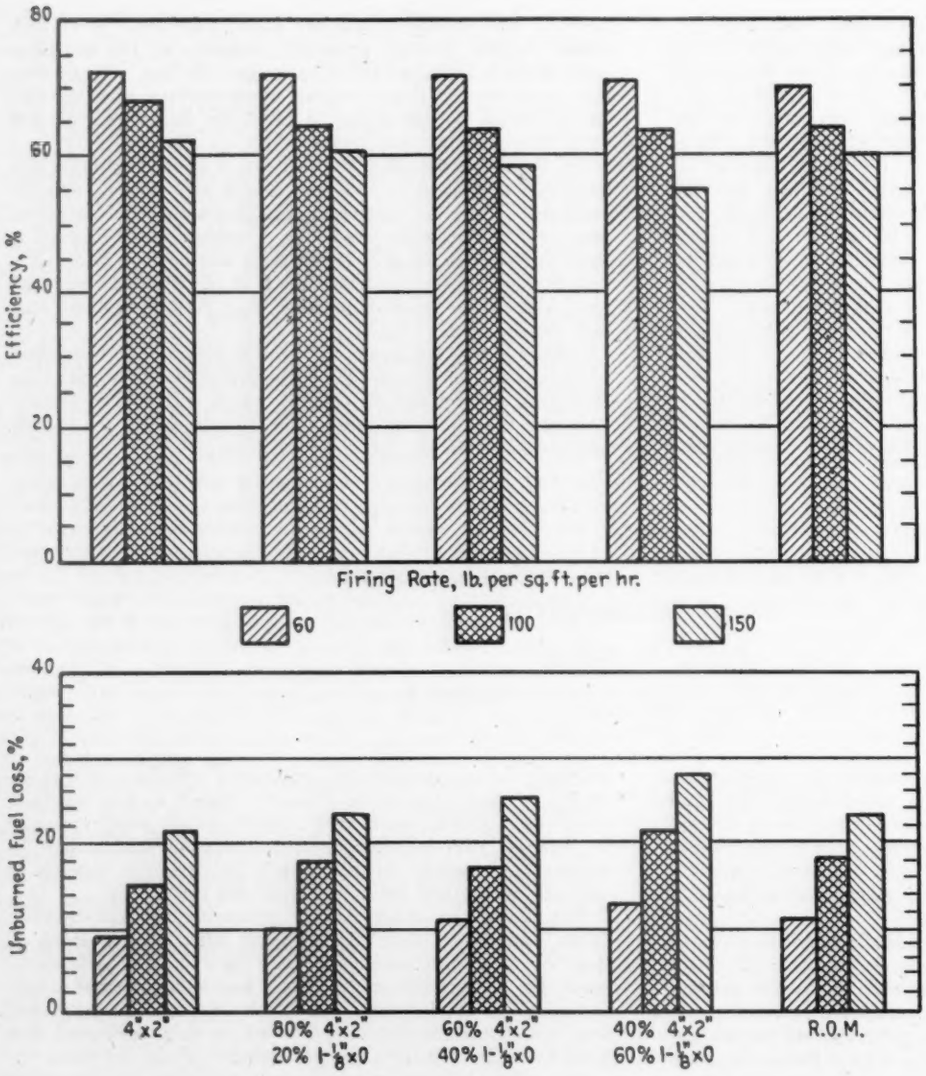
Since the particle size of the fuel being projected into the gas stream is one of the primary factors controlling the quantity of carry-over, losses could conceivably be reduced by providing to the fuel bed coal which has a minimum amount of fine sizes. A second way, which has often been proposed for keeping this loss to a minimum, is by collecting the cinder particles in the front end with separating arrangements, and reinjecting them into the firebox for reburning. Research is now being done at Battelle, by scale-model methods, toward the development of a successful cinder collector which acts on a centrifugal principle; it is being designed to meet the space limitations in the front end.

The Effect of the Stoker

The degradation of the fuel occurring in the stoker conveyor screw is commonly believed to be contributory to the high unburned-fuel losses. Tests conducted jointly by the Standard Stoker Company and the Pittsburgh Coal Company on an HT stoker for the New York Central System have shown that the amount of degradation chargeable to the stoker is related to the dimension of the top size of the coal and to the percentage of the fine coal supplied to the conveyor mechanism. These show that coals having either the smallest top size or the largest percentage of bottom size gave the least amounts of ⅜-in. chargeable to the stoker.

If the top size is 4 in. or larger, considerable degradation occurs because the stoker is equipped with a crusher block which breaks the coal to a size which can be distributed in the firebox. The steam jets used to distribute the coal are unable to distribute large pieces over the entire length of the firebox. The optimum minimum bottom size of each coal is yet to be established.

* The locomotive used is a New York Central Class J3a 4-6-4 type.



Comparison of efficiency and unburned fuel loss for tests of Pittsburgh bed coal

Results Due to Variations in Heat Value, Ash and Volatile Content

Although the standing tests failed to evaluate the effect of heat value, ash or volatile content, they may become important in road operation. This is especially true of the amount of ash in a coal which is often the controlling factor limiting the availability of the steam locomotive. If a high-ash coal is used, undesirably frequent cleaning of fires and ash pans is required. On the other hand, choice commercial low-ash coals often fail to give performance in locomotive service commensurate with their quality because not enough ash accumulates on the grates to hold the fire and high ash-pit losses occur.

Honeycombing and Clinkering Characteristics

Severe honeycombing and clinkering characteristics occurred with fuels in which the ferric-oxide, Fe_2O_3, content of the ash exceeded 32 per cent. However, in only a few instances in these tests was this severe enough to cause steam failures primarily because the test periods were too short for an excessive accumulation of honeycomb or clinker.

When the amount of Fe_2O_3 in the ash ranged from 16 to 32 per cent, honeycombing occurred at high rates of output and some clinkering of the fuel bed was evident. However, no clinkering or honeycombing occurred with any fuel with an ash of less than 16 per cent Fe_2O_3.

The values for the average ash-softening temperatures for the coals bore a less definite relation to the clinkering and honeycombing characteristics. In general, if the ash-softening temperature was high, 2,600-2,800 deg. F., no honeycombing or clinkering occurred, whereas, if this value was between 2,000 and 2,500 deg. F., both were evident.

Effect of Unburned-Fuel Loss

The over-all efficiency and, consequently, the evaporative capacity obtained with a particular type of coal were found to be governed principally by the losses caused by the discharge of unburned fuel or cinder from the stack.

Although no data are available, it is logical that a relation exists between the unburned-fuel loss incurred with any fuel and the quantity of fines or slack which reaches the fire box regardless of the original top size. For instance, the amount of minus ¾-in. or minus ⅜-in. coal may be more indicative of the unburned-fuel loss than the amount of minus 1⅛ in. shown in some of these tests. If this relation of the size of the coal to the efficiency were definitely established by more tests and the screen analysis of the fuel reaching the fuel bed were known, the performance of any fuel could be accurately judged for all operating conditions. This possibility should be recognized in further work.

Economies of Coal Selection

From the data on the evaporation per pound of coal with each of the coals tested in this program, one could rate the coals in the order of their value. These calculated ratings are not presented in this paper because they might be misinterpreted. Other

factors beside evaporation are important in the selection of a coal; these include the effect of the coal on the availability of a locomotive, the reliability of a continuous supply of the coal, and the uniformity of the quality of the coal.

The basic data required for the selection of the most economical coal are those on the evaporation, or the degree of difficulties to be expected from the coal, and on its limitations in capacity of the locomotive. However, only well-planned and executed tests will definitely establish information for other classes of power. With such information available for the coals in its area of supply, the fuel department of a railroad could readily make a selection of the most economical coals for use.

Water Treatment and Fuel Saving

By A. G. Tompkins

Supervisor of water treatment, Baltimore & Ohio

Scientific locomotive feed-water treatment has been a major factor in the constant reduction of fuel required per thousand gross ton miles by steam locomotives on American railroads. Water treatments produced by modern science have made possible the long locomotive runs, the almost universal 30-day washout, the scale- and corrosion-free heat transfer surfaces, and the almost complete elimination of delays due to boiler failures or foaming.

The first official investigation of effects of poor water on locomotive costs was made about 1870 by the American Railway Master Mechanics' Association. Despite this report there was no progress in water treatment until 1891 when the Union Pacific installed the first water treating plant for boiler use on any American railroad. About 1900 the founders of the American Railway Engineering Association encouraged a study of locomotive water supplies, and the proceedings published in 1905 mentioned the water softening plants on the Pittsburgh & Lake Erie, Santa Fe, Chicago & North Western, Rock Island, Southern Pacific, and the Union Pacific. In this same year the Baltimore & Ohio pioneered its first railroad water softening plant at Glenwood, Pa.

Continued studies by the American Railway Engineering Association resulted in a report in 1914 establishing a figure of 7 cents as the average cost to the railroads for each pound of scale forming material in untreated feed-water. In 1924 the figure was raised to 13 cents. The Master Boilermakers Association in 1945 recommended that on the basis of increased labor and material costs the minimum savings should be 22¾ cents per pound of scale-performing solids neutralized or removed. Since labor, fuel and other material costs have continued to rise sharply since that time, it is felt that the 22¾ cents figure is extremely conservative. On this basis the B. & O. in 1948 showed a net savings of $2,600,000 with an estimated removal of 14,300,000 lb. of scale forming solids and mud. It should be noted that this figure does not allow for costly corrosion of soft waters or for extreme damage done by high silica waters.

As the savings available to the railroad through water treatment became more apparent, railroad management appropriated more money for locomotive water conditioning facilities. Research and field development work by water-treating companies and by the railroads resulted in much improved treating chemicals and in the development of automatic proportioning equipment. Today the B. & O. operates a total of 200 plants for the treatment of locomotive water supply with annual output of some 15,000,000,000 gallons of treated water.

Scale

The most obvious fuel saving through water treatment is obtained by the maintenance of scale-free conditions on the water side of the boiler heat-transfer surfaces. The extent of fuel loss and damage done to a heat-transfer surface will depend on the rate of heat transfer, type of scale, and thickness of the scale. A high heat transfer area such as the crown sheet can tolerate practically no scale compared with a low heat transfer area such as the front portions of a flue. Silica is the most damaging type of scale as even paper-thin layers of this porcelain-like material will cause difficulty in a very short time. Calcium sulphate forms a dense scale which can cause severe over-heating and metal failure. Calcium carbonate scale is generally rather porous and can be tolerated in somewhat larger quantities, although with modern high-pressure, high-heat-transfer boilers, even this scale must be considered dangerous. Oil has no place in the boiler as it forms a film on the metal surface which performs the same harmful function as scale.

Without water treatment washing of locomotive boilers was often necessary three to six times every month, with water changes frequently being made every round trip. The extension of period between washouts to 30 days with the elimination of water changes made possible by water treatment permits a very substantial savings in fuel required for firing up. In addition to the saving in coal or oil, the extension of the period between washouts allows greater locomotive availability. It is also very desirable to hold the number of washouts or water changes to a minimum to reduce the expansions and contractions of the sheets and flues as these materially shorten the life of a boiler. The harmful effects of such contractions and expansions can be lessened very appreciably by precooling the boiler and by using care to fire up the boiler slowly. This is particularly necessary with the newer, larger power which, because of higher pressures and larger dimensions, have much greater overall thermal stresses whenever it becomes necessary to remove the water from the boiler.

Foaming

The newer, more powerful steam locomotives with their higher heat transfer ratings, higher steam pressures, but with relatively smaller steam spaces have made the old problem of foaming and carryover more intense. Fortunately, water-treatment research came through with an answer—modern antifoams; more correctly, they should be called steam conditioners as their function is not only to eliminate foaming but to assure dry steam by reducing carryover to a minimum.

Before the introduction of these steam conditioners, the only solution to foaming was to blow the boiler down and add fresh water so as to keep the total dissolved solids in the boiler water below the normal foaming level, which was generally 125 to 150 grains per gallon. The amount of blowdown to keep below the foaming range usually ran from 5 per cent to 20 per cent of the total water evaporated. While a good portion of the blowing was usually done on the road, a large portion still had to be done at the terminals, taking from 5 minutes to 3 hours or even requiring a complete water change. Obviously, such terminal delays seriously interfered with locomotive availability.

Of primary interest here, however, is the fact that the 5 to 20 per cent of the boiler water blown out was hot water, the greater part of which need not be lost if steam conditioners were used. The potential savings in fuel which can be accomplished by such blowdown reduction and which many roads are now obtaining, are considerable. At one terminal only, on one of the larger roads, a saving of 12,000 tons of coal annually was accomplished through reduced blowdown made possible by the use of antifoams.

The extent of reduction of locomotive blowing through steam conditioners should be determined by qualified personnel. The key factor in this decision is no longer the dissolved solids, but the type and volume of suspended solids in the boiler water. It is generally desirable to flash blow the boilers at the terminals to insure removal from the boiler of settled suspended solids. For example, one road that pioneered the use of steam condi-

tioners requires only three flash blows of three seconds each at the engine terminals; this flash blow at terminals has been standard practice for six years with a report of foaming being extremely rare.

Reduced blowdown through the use of steam conditioners results in a corresponding saving in water consumption; this reduced water consumption is particularly important on the road, where it may mean the elimination of a water stop on tight runs. Other savings to the railroads through use of steam conditioners include fewer man hours devoted to blowing boilers, reduced terminal time for handling locomotives, and elimination of nuisances of vapor, blowdown water, and excessive smoke.

Wet steam is costly in that it reduces superheat temperatures. One per cent moisture in the steam will drop the superheat temperature by 17 deg. F. Carried along with any moisture to the superheater are the dissolved and suspended solids of the boiler water which will deposit in and possibly plug superheat units. If the carryover is severe enough, the entrained boiler water with its solids may reach the valves and cylinders where it may destroy lubrication, resulting in scored cylinders, loss of packing or even destruction of the cylinder.

To attempt to operate a modern steam locomotive without modern water treatment is to impose an operating and economical handicap on a railroad which is practically insurmountable in the very competitive transportation field of today.

Discussion

In answer to a questioner who thought that compound balls dissolve too slowly following a water stop, Mr. Tompkins said that the practice on the Baltimore & Ohio is to add the compound balls when the locomotive comes into the terminal. Then, by the time it is ready to go out, enough compound has dissolved to be effective. The ball compound is added thereafter at every water stop except where anti-foam compound is automatically fed in with the water. Mr. Tompkins did not think that there were any ill effects resulting from a little excess of compound.

Mr. Tompkins said that engine crews are not held responsible for maintaining any minimum concentration of dissolved solids in the boilers on the B. & O. and that they are trying to arrive at a point where no road blowing will be required, and flash blowing in the terminals will suffice. On the Chicago & Illinois Midland the crews are held responsible for keeping the total dissolved solids within a specified maximum, a practice which is said to work well and in carrying out which the engine crews co-operate.

Education of Steam Engine Crews

By A. H. Glass

Chief power and fuel supervisor, Chesapeake & Ohio

The Fireman

The selection of prospective firemen is based on their character, public or private schooling and previous experience on the railroad. He is given a list of questions which must be correctly answered by the end of one year, at which time he is given the second-year questions and finally the third-year list, after which, if correctly answered, he is eligible for position as engineman.

The methods of firing must be suitable to the grade and variety of the coal used, as must be the ash-pan, grates, firebox, and draft adjustment. The fireman should have sufficient knowledge of these devices to know when all conditions are suitable for the coal supplied. Where conditions will permit, each coaling station should be supplied with the same grade and type of coal and the locomotives should be properly equipped and drafted to turn it. Unfortunately, however, due to general conditions, many grades of coal are supplied and these must be burned in the same firebox and the fireman must learn to obtain the best results with each. The fireman must actually burn the coal to decide what method to use to obtain best results.

If the fire is not put in good shape before the starting of the trip, it will give the fireman all kinds of trouble. For that reason, he should arrive at the assigned locomotive at the required time in order to prepare the firebed, and thus save himself much worry and labor during the run.

On arriving at his engine, he should see that the fire has been well cleaned. Next, he should close the firedoor and put the blower on long enough to start the fire burning brightly so that he can detect any dead spots in it. The green coal should be pulled away from the dead spot, the grates covered with good live coals, the green coal spread over the live coals, and the blower applied just long enough to ignite the green coal thoroughly. After the fire has been put in good condition all over the grate surface, fresh coal should be lightly spread over it, and if necessary, the blower put on very lightly.

After the fresh coal that has been spread over the fire is at a cherry-red heat, continue the building up process by spreading fresh coal thinly, first over one half of the firebox, lengthwise, and then over the other half. The idea is to always have one half of the fire at a red heat or better, when fresh coal is put on the other half, so that sufficient heat will be assured to burn the gases as they are driven off from the added coal. This will materially reduce the smoke produced in building up the fire.

It is of great importance to have a good fire covering the entire grate surface before leaving time for the trip. Its depth must also be consistent with the service performed.

If, after having put the fire in good condition as outlined above, it is found that the locomotive must stand for even a short time before leaving the terminal, it is desirable to bank the fire around the sides and at the back, using the so-called horseshoe method. This horseshoe bank should not be disturbed prior to actually leaving the terminal and while at the terminal just enough coal should be added to the center of the firebox to maintain steam pressure on the boiler. Care should be exercised to see that the safety valves do not raise while maintaining the fire when standing on the ready track, thus preventing a waste of fuel. After leaving the terminal the center of the horseshoe should then be filled in by hand, using the blower and smoke consumer until the smoke clears up. The stoker should be tested while the locomotive is on the ready track to make certain it is in good operating condition before leaving the terminal.

The steam gauge and the smoke stack are the best indicators of the condition in the firebox and these should be closely watched by the fireman. When the steam pressure begins to fall under apparently favorable conditions, the fireman should examine his fire for banks, holes, or clinkers. In fact, he should make a practice of inspecting the fire frequently enough to enable him to carry a mental picture of its condition at all times.

It would be comparatively simple to fire a steam locomotive, if it could be operated at a constant speed, and if the profile of the road was such that the work required over the entire run was uniform, and if the fuel burned was always uniform in size and chemical composition, because then the jets could be set at a pressure that would produce equal distribution and the rate of delivery of coal into the firebox could be set when leaving the terminal and it would not be necessary to make any changes until arrival at the next terminal. This, however, is never the case and firebox conditions change when the coal changes from lump to slack or from slack to lump, each requiring changes in jet pressures and in stoker speeds. Likewise easing off on the throttle and shortening the cut-off requires a decreased amount of coal in the firebox just as increasing the cut-off and widening found that the most satisfactory way to inspect the fire is first

to shut down the stoker engine, close the main manifold jet steam valve and where possible wait a few seconds for all the volatile gases to be driven off and burned before opening the firedoor. The stoker engine steam gauge and the manifold jet gauge should be observed before closing the steam operating valves to these devices because this will give the fireman a basis for resetting these pressures when operation of the stoker is resumed.

After the stoker operation has ceased, the smoke consumer should be turned on. This will assist in quickly burning the volatile gases driven off from the green coal and will assist in the elimination of black smoke. Then open the firedoor, check the depth of the fire, look for light spots and banks, observing particularly the back corners as these are often a source of considerable trouble. The depth of the fire can be gauged very accurately by estimating the distance between the fire and the distributing table or by checking the distance from the fire to the smoke consumer tubes. It is considered good practice to maintain the depth of the fire less than eight inches in thickness and it must be kept free from banks and light spots.

After a careful inspection of the fire has been made, close the firedoor and resume stoker operation. Reset the stoker jet pressure using the same pressure as originally maintained unless conditions in the firebox indicate that more or less pressure is required to maintain an even depth of fire over the grates. Fill in light spots, using the scoop if necessary, and burn out or break up any existing banks.

It is always well to perform routine duties in a systematic manner; therefore, if the fireman will set up a mental picture of what is required and perform his work in the same chronological order each day, it will become a habit and the possibility of overlooking some important detail will be eliminated.

The Engineman

The engineman should have acquired a complete knowledge of the locomotive and auxiliaries in the pursuit of his duties as a fireman so as to enable him to operate the locomotive and obtain the highest possible rating with a minimum of fuel. Principal factors that contribute to good performance are, briefly, as follows:

When pulling out of a terminal, station, or siding, every effort should be made by the engineman to avoid starting the injector until the fireman has the fire in good condition and until the steam pressure is increasing; otherwise, the fire will have to be crowded to hold up the steam pressure.

The engineman must not operate first with a light throttle and then with a heavy throttle, nor should he change the cut-off more frequently than is necessary because this makes it impossible for the fireman to carry a uniformly steady fire and an even steam pressure. He should avoid slipping the locomotive because this has a tendency to tear holes in the fire.

When approaching shutting-off points, the engineman should notify the fireman sufficiently in advance so that the fireman can allow the fire to burn down somewhat, thus preventing a waste of steam through the safety valve and making black smoke. He should see that the water level is such that the injector can be put on, if necessary.

The engineman should supply feedwater to the boiler uniformly, maintaining the water level in the boiler in such a manner as to avoid carry-over into the cylinders and steam passages. The water level should be held as low as safety will permit so that the steam will be as dry as possible when it enters the superheater.

Where operating conditions will permit, the valve cut-off should be held to a minimum with full throttle to reduce drop in steam pressure between boiler and steam chest. The highest possible degree of superheat is then obtained.

The engineman and the fireman should take every opportunity to get all the information possible about their jobs. They should become familiar with the operation of the various devices and equipment used on locomotives by reading the catalogues and instruction manuals supplied by the manufacturers. They should consult the traveling firemen and road foremen of engines as well as the older, more experienced enginemen, about their problems so that they will be well informed as to all forms of operation, can use good judgment at all times and know how to handle emergencies. They should keep especially well posted on all general as well as local rules and instructions.

Locomotive Fuel Oil

By G. E. Anderson

General fuel supervisor, Great Northern

To obtain economical operation the oil-burning equipment must have good burner adjustment, with the proper amount of air to produce proper combustion to burn a clear stack. The front-end door and ring must be tight, and there must be no air leaks around connections leading to the front end or around the corners or sides of the fire pan at the mud ring.

The air admission for proper combustion, controlled by a front damper regulated from the cab or by side dampers located near the flash wall, or air admission through the fire door with a deflector inside the fire door, helps to deflect and direct flames into back corners of firebox and aids combustion by providing the proper air mixture. On some railroads side air vents operate automatically, admitting air required for combustion.

We have engines equipped with brick arches, using arch tubes and circulator for supporting the arch. Best results are obtained where the arch is not over four rows high. The fireman can then get sand over the arch to sand out flues properly, and the arch protects the flues from excessive cold air if the fireman uses too much front damper.

After the train gets to maximum speed, or if there is a high quartering wind, it is better to use reduced front damper. This helps to prevent heavy wind velocity forcing flames to the side of the fire pan and producing a cloudy fire and stack smoke.

With a duplex 5-in., 250-lb. gauge for indication of atomization pressure and the pressure used for heating the oil, the fireman can control pressure to where best results are obtained.

A strainer in the oil line, so arranged that it can be cleaned out very quickly has prevented delays and steam failures.

The fireman must have a free working firing valve. A valve that operates hard does not give perfect control of the fire.

In districts where winter temperatures range from 0 to —35 deg. F., the fireman must be watching the oil temperature constantly, for if fuel oil becomes too hot, it will cause trouble and cold oil will not burn properly but result in excessive carbon on the flash wall and a poor-steaming engine.

During 1911 when there was not such a great demand for heavy fuel oil, oils were much thinner and required less heat for unloading and handling on the locomotive to produce proper burning. It was found that an oil temperature at 100 to 110 deg. was sufficient to give very good results. In order to get results from some of the heavy fuel oil today, the temperature of oil must range from 135 to 175 deg., depending upon the oil.

Our fuel-oil specification calls for viscosity of the fuel oil furnished during summer months not greater than 150 Saybolt Furol at 122 deg. F. During the winter months it is to be not greater than 100 Saybolt Furol at 122 deg. F.

The problem during cold weather when temperatures range from 10 to 35 deg. below is getting sufficient oil out of cars during the time the oil is being heated to prevent it from expanding too fast and running over the top of the expansion dome. On cars not provided with heater coils we put steam directly into the oil, through a 1-in. pipe with a short nipple on the end resting on the bottom of the car, heating the oil around the unloading valve and forcing steam along the bottom of the car to the ends.

Oil heavier than 100 viscosity requires more steaming to get it hot enough to run freely, and after the car is partly unloaded we find the ends of the car still cold. The oil remaining in the car will require a higher temperature to get it to draw out.

We have got oil from a car during the winter months where the viscosity Furol at 122 deg. F. was 250 sec. With such oil complaints are made regarding poor-steaming engines. It must be excessively hot to operate. To prevent trouble, 200 to 400 gal. of Diesel oil were added at each locomotive supply. This improved the efficiency.

In checking firebox temperatures with pyrometer where oil was up to standard and the locomotive was running at a speed of 60 m.p.h., the firebox temperature was at 2,450 deg. F. With no other change in firing operation than increasing the opening of the front damper, this slight change caused a drop in temperature of 200 deg. F. in the firebox. When the front damper is wide open, by cutting it down the firing valve can be reduced two or three notches, retaining full steam pressure with a clear stack.

L.M.O.A. Concentrates on Diesel-Electric Problems

G. E. Bennett, President
(Superintendent motive power, C. & E. I.)

THE Locomotive Maintenance Officers' Association this year had the largest registration among the railroad groups meeting at the Hotel Sherman, Chicago, for the three-day meeting, September 18 to 20 which bears evidence of the broadening interest on the part of both mechanical and electrical men in the increasingly complex problems of the maintenance of Diesel-electric motive power. During the six sessions of the Locomotive Maintenance Officers' Association meetings, technical reports were presented dealing with mechanical and electrical maintenance of Diesel-electric power; terminal facilities for both steam and Diesel maintenance; shop practices and tools. An individual paper on tonnage ratings for Diesel locomotives was presented at the first sessions.

At the afternoon session on the first day, E. H. Davidson, director, Bureau of Locomotive Inspection, Interstate Commerce Commission, spoke to the membership on a variety of problems with respect to maintenance and safety of operation. In his talk, Mr. Davidson again called attention to the alarming increase in the accident frequency rate connected with steam power and asked the cooperation of mechanical men in bringing about an improved standard in steam locomotive maintenance.

Speaking of the growing importance of Diesel-electric maintenance and its relation to safety of operation, Mr. Davidson said: "The pattern of accidents involving Diesel-electric locomotives is gradually developing, and includes both the poor housekeeping type of accident and accidents incident to a relatively new type of power. I commented upon two of the latter types—crankcase explosions and failure involving traction motor bearings—when I met with you last year. I am happy to report that accidents from these causes have shown a noticeable improvement since that time.

"Information received indicates that application of Diesel engine lubrication oil testing procedures by many railroads—which includes establishment in some instances of oil testing facilities at Diesel terminals—has resulted in early discovery of potentially dangerous conditions. Correction of these conditions prevented the accidents which could have occured had the situation been permitted to continue without attention. The absence of accidents caused by traction motor bearing failures is indicative of the increased attention given to lubrication and maintenance of these bearings.

"During the past year a serious accident occurred as the result of a failure of a Class B wheel under a Diesel-electric locomotive unit. A number of other wheels under Diesel-electric units upon various railroads have failed, but fortunately did not result in casualties.

"The service in which the wheels of Diesel-electric units are employed is most severe, and the character of resulting stresses is complicated. The problem is being studied by the railroads, the mechanical committees of the A.A.R., and the wheel manufacturers and technical institutions. It is to be expected that stronger and more enduring wheels will result.

"Experience to date indicates that many of the cracks which occur in plates or rims of wheels are progressive in nature, and in appearance are characteristic of fatigue failures. These cracks have been found to originate in surface defects such as nicks, cuts, gouges or tool marks, which, in addition to stenciled indentations, appear to be focal points of concentrated and localized stresses, or may in some instances have been caused by steel composition at point of failure.

"Total mileage and the number of times a wheel has been turned also seem to be pertinent to the problem. Wheel wear generally appears to be progressively more rapid as the chilled tread metal is worn off or removed as the wheels are turned. Because of the more rapid wear of wheels between subsequent turnings, and the greater susceptibility to cracking or other damage, and the impossibility of applying a varying standard of inspection, it is essential that each wheel under a Diesel-electric locomotive unit be continually under observation, and that all inspections made be thorough and meticulous.

"During the past year we have investigated a number of accidents in which injuries of varying severity resulted from falls caused by defective structural condition of or oil on walking surfaces. Consequently, minor displacements, obstructions, and oil or grease are frequently overlooked, and falls occur before the victims are consciously aware of a hazardous condition.

"Corrective action necessary to eliminate defective structural conditions is obvious, and needs no further comment. Accumulation of oil or grease on walkways is a condition that can and often does develop after a locomotive has received all indicated terminal repairs.

"On oil-burning steam locomotives oil is frequently spilled at the time of refueling and, because of its loca-

tion on top of the tank, where footing at best is not too secure, it presents a very hazardous condition, particularly when employees are on the tank during hours of darkness.

"The problem with respect to Diesel-electric locomotives is more complicated. Because of extent of the fuel and lubricating oil distribution systems, the length of engine structure, numerous pipe connections, and the many covered openings about the engine structure, a considerable number of locations of potential oil leaks exist. Our inspectors have reported a great many Diesel-electric locomotives as defective during the past year because of the condition of floors and walkways. There is room for material improvement in this respect, and I trust that you gentlemen will be able to exert as effective an influence in the matter during the immediate future as has been accomplished with respect to crankcase explosions."

Election of Officers

The following officers and board members were elected to serve for the year ending in September, 1951: President, P. H. Verd, superintendent motive power and equipment, Elgin, Joliet & Eastern; first vice-president, H. H. Magill, superintendent of locomotive and car shops, Chicago & North Western; second vice-president, S. M. Houston, assistant general superintendent of motive power, Southern Pacific; third vice-president, F. D. Sineath, assistant general superintendent of motive power, Atlantic Coast Line; fourth vice-president, T. T. Blickle, executive assistant, mechanical, Santa Fe; secretary-treasurer, C. M. Lipscomb, assistant to schedule supervisor, Missouri Pacific.

Executive Committee (two-year term): E. Abraham, assistant to superintendent of motive power, Elgin, Joliet & Eastern; F. R. Denney, assistant mechanical superintendent, Texas & Pacific; A. E. Rice, chief mechanical officer, Denver & Rio Grande Western; W. E. Lehr, superintendent of motive power, Lehigh Valley; P. H. Hatch, general mechanical superintendent, New Haven; F. W. Bunce, chief of motive power, Chicago, Milwaukee & St. Paul; A. L. Wright, superintendent of equipment, New York Central.

Training Diesel Supervisors

The requirements of a training program which has been approved by practical application furnish the basis of this report. The report includes the outline of the personnel from which Diesel supervisors must be drawn and the type of training which it is believed best suited for rounding out their education. A section of the report lists the duties of a supervisor and the objectives and scope of the training program. After these preliminary details the report goes into the set-up, both on the railroad and in manufacturers' plants, for training men, the principal features of which follow.

Staff for Instruction and Training

The basic organization to carry out a complete training program would contain the following elements:

The Training Plan: This covers the entire program of a trainee from the time he is selected to receive the training through the training period and concluded with the presentation to him of a certificate or letter acknowledging his successful completion of the program. It includes the selection of each item of training aids, each step through the separate phases of the training. It includes the selection of the type of equipment to be used in the company school, shop, and to what manufacturer's schools the trainee will be sent.

The equipment for company schools: Such equipment may be drawing tools, engine or parts of engine and its accessories. There should be diagrams of the electrical, water, oil, fuel circuits. We should have a steam generator where men can learn the safety factor. The movie film, slides, projectors, and similar visual aids are valuable equipment. It is better to instruct by seeing and doing the work than by reading it. Equipment may be located in a car, truck, room, or the shop. Cut-a-way assemblies and actual working models and mock-ups should be provided.

The instruction manuals should always be used and not laid away. The purpose of the manufacturer is to sell the mechanics the right way to do the job. The supervisor must learn how to use the manual. He must be prepared at all times to help some mechanic who is in trouble.

The Diesel engine and its electrical circuits calls for precise work. The supervisor must learn how to use meters, and other electrical instruments and how to read charts. From the proper information he can instruct his men correctly. All the necessary tools he must know. A mechanic must also work safely. The supervisor must prove to himself that the tools are used correctly. The steam machinist can learn to do Diesel work if the supervisor can instruct him. The precise instruments must be thoroughly understood, remembering men must work within thousandths of an inch. Therefore, such items as "meggers," all

P. H. Verd,
First Vice-Pres.
(Superintendent motive power and equipment, E. J. & E.)

H. H. Magill,
Second Vice-Pres.
(Superintendent locomotive and car shops, C. & N. W.)

S. M. Houston,
Third Vice-Pres.
(Assistant general superintendent motive power, Sou. Pac.)

C. M. Lipscomb,
Sec.-Treas.
(Assistant to schedule supervisor, M. P.)

types of electrical meters, the high potential test machine, dial indicators, torque wrenches, battery maintenance equipment: all should be used in the classroom and on actual equipment being inspected and repaired, to impress on the trainee the function of each of these instruments.

The approach to educational efforts is based on a clear conception of fundamental elements and the study of equipment should be along the lines of : 1. What is it?; 2. Where is it?; 3. What is its function?; 4. How does it work?; 5. What do you do if it doesn't work?

This can be developed until complete diagnosis of operation and troubles can be worked out.

The supervisor (trainee) has the use of the visual aids but he cannot depend alone on it, he must also "learn by doing" and by reading and studying material concerning the job to be discussed. The instructor must be ready to introduce the film or slides so as to prepare the supervisor for the instructions. Then after the film, discussion should follow to clear the problems that might arise. Visual aids should be used in all instruction.

Manufacturers' Schools: Some railroads depend on a school which is supervised by the manufacturer. The manufacturers have their own school with their instructor. This instruction is over a short period of time and the supervisor then must study on his own time to complete the material that was given him. This written material is written with care so that the supervisor will understand it.

The manufacturer's participation in the training program should cover the component parts of the equipment and its functions. The training should point out the relationship of the various pieces of equipment and their purposes. The design and operating principles should be pointed out and discussed for clarification.

The supervisors should be given a clear understanding of the operations, maintenance and functions of all the component parts that make up a Diesel-electric locomotive.

The programs of the manufacturers' schools will serve as a guide for study by railway companies to set up a company program and school or it may be studied for evaluation in using the manufacturers' school in conjunction with company training: that is, a manufacturers' school would be selected to send a "trainee" to for a "post graduate" period of advanced training.

Inasmuch as the objective of the training is to keep trains moving with equipment operating at highest efficiency with lowest maintenance costs and longest possible life and maximum utilization of facilities and labor, it is immediately apparent that the costs of training will be justified by achieving this objective. In fact, this is the only reason which could move railway management to set up such a training program. The results of present experience prove that the supervisor who was given a complete knowledge of the machine and mastered the maintenance problem of all its details has more than repaid the investment in his training. Many examples of continuous daily effort which are improving operation, meeting and overcoming innumerable obstacles standing in the path of maximum performance and resulting in satisfactory locomotive utilization and maintenance are to be found all over the country; in large shops and round houses, and at isolated intermediate division points. All of this can lead to but one conclusion. The achievement of proper Diesel supervisory training will greatly add to the daily performance of Diesel operation which is contributing to and will continue to contribute to, the greater service of the railways to the nation and to the world.

The report was prepared by a committee of which L. J. Brasheer, assistant master mechanic, Belt Ry. of Chicago, was chairman.

Mechanical Maintenance on Diesel Locomotives

This year's report of the committee on the maintenance of Diesel-electric locomotives consisted, as before, of a general division between mechanical and electrical maintenance information. This abstract consists only of the mechanical maintenance section which was further subdivided into three topics, viz., cost accounting for maintenance, air and oil filter maintenance and steam generator maintenance. The section on cost accounting showed the break-down on costs between engine, electrical and car body on one road was 34, 31 and 35 per cent respectively.

Air and Oil Filter Maintenance

It is imperative that air filters be properly applied and serviced to realize the benefit they are able to give. Improperly applied, loose filters or defective filters such as settling and disintegration of the media will allow unfiltered air to enter the engine or engine room. In servicing of the air filter, it is of the utmost importance that they be well oiled with a proper kind of oil. If filters are not kept oiled, the dry wires will be unable to collect the dirt, resulting in the dirt passing through the filter with the air. The air filter is designed and installed for the purpose of protecting the engine from unnecessary wear and to help maintain a clean and attractive engine room. The cost of providing suitable air filter servicing equipment and the servicing of the air filter is far less than the replacement of worn parts.

At small terminals where operation does not justify automatic equipment, a definite step procedure must be set up properly to clean the filters. This can be accomplished with a minimum amount of equipment as outlined below:

1. Wash dirty side of filter using a hot water hose preferably with a sharp stream until clean. Drain excess water and shake filter sufficiently to drain any trapped water.

2. Submerge filter in a suitable cleaning solution, selecting a compound that will not attack the media. A slight sloshing motion or agitation shortens the cleaning time.

3. Drain solution from filter and rewash with hot or cold water hose, drain excess water, shaking filter sufficiently to drain any trapped water.

4. Submerge filter in a suitable oil and of proper viscosity.

5. Place filter on a storage rack for at least 24 hours before using, to insure proper drainage. Filters should be placed on the rack consistently so that filters being taken for use will not be over dry or over oiled.

The above procedure, with sufficient spares, has proven very successful on our railroad at outlying terminals, where only a few switchers are handled. To speed up this operation, filters can be placed in heated ovens to accelerate drying after washing and oiling. This, however, creates a problem of additional space and equipment. Considering this new problem, an automatic washer and cleaner becomes almost a necessity. Advantages of being able to use filters immediately after oiling, maximum production in a minimum of space and time, and reduction of space material, is helpful in handling the storage problem.

The servicig period—Regular servicing periods set up for practicability, economy and performance are a necessity. Type of service, territory, and climatic conditions must be considered by each railroad and the service periods adjusted accordingly. On one railroad, engine air intake filters on passenger locomotives are serviced at approximately 5,000 miles. Carbody filters should be changed about every two weeks. In freight service, engine air intake filters are serviced every 5,000 miles or two weeks.

With the above extended mileage servicing, it is imperative that the supervision give special attention as to the condition of the filters in between servicing periods. Continued hot and dry weather, dust storms, etc., sometimes necessitates filter changes in between regular service periods. Inspection of filters to determine the servicing period, one should observe closely the ditry condition on the downstream side of the filters and the amount of dirt load on the filter. The gradual build up of dirt continues layer on layer

until filter is practically plugged or until the dirt has absorbed all of the oil. This overloading of the filter will cause a pressure loss through the filter or if all of the oil has been absorbed, dirt will pass through the filter. Permitting filters to dry out, which might be a result of not using the proper oil, improper servicing such as overheating, or too infrequent servicing, will allow dirt to pass through the filter even though the filter is only slightly loaded with dirt and apparently serviceable, but actually the wires are dry, therefore, will not give proper air filtration.

After having selected or adopted the desired type of make of filter, then the one all important single factor that controls the efficiency and dirt holding capacity of the filter is the adhesive. The dirt holding capacity of an impingement type filter is in direct proportion to oil holding capacity. The amount of oil that a filter can hold and use effectively is determined by the viscosity of the oil and its wetting characteristics. A decrease in wetting character will cause a decrease in efficiency, therefore, it is necessary to tie-in viscosity with the wetting characteristics.

Oil filter maintenance and lubricating oil inspections are closely related. Most railroads are using a sock type cotton waste filter for filtration of the lubricating oil. The waste or waste sock element, after it has absorbed the free carbon and other contaminations from the lubricating oil to a maximum saturation point, are then removed and destroyed. To date no satisfactory method, or at least an economical method, has been found to reclaim the waste. Some railroads, after reclaiming the waste, have attempted to use the reclaimed waste in freight car journal packing. We have been unable to develop any substantiating facts on this performance; it is generally feared that this type of waste tends to increase hot box difficulties on the cars. This is something that should be given serious thought and further testing.

At this point, in the report, a description of the blotter test method, with which most maintenance men are familiar, was included.

Steam Generators

The final section of the report outlined the development of the steam generator and considerations involved in maintenance and included in the report some of the variations which one or more roads have made with respect to maintenance schedules. One such variation is as follows:

1. Suction and pressure water strainers are cleaned at certain originating terminals representing 2,500-mile inspection instead of 5,000 miles.
2. On the 5,000-mile inspection, all remote controls are tested and damper shaft lubricated.
3. In Transcontinental service, due to our poor water condition, coils are worked every other trip or approximately 10,000 to 12,000 miles.
4. No water treatment is used, therefore, no injector pump maintenance. All treatment tanks have been removed from the locomotives.
5. Stack switches are removed and setting checked, steam temperature limit control repacked and blower fans cleaned each quarterly inspection, plates have been applied to the fan housing for accessibility.
6. Steam generator coils are removed every two years. The coils are cleaned, washed, hammer tested and given a hydrostatic test of 1,200 lb.; usable coils are returned to service.
7. Each five years lagging is removed from steam separator and separator inspected while under hydrostatic pressure.

It has been practically impossible to secure up-to-date instruction and the proper testing equipment for use in overhauling the control equipment and accessories when removed from the steam generators. This has resulted in waste of man hours and efficiency to say nothing about the controls not working properly when reapplied to the steam generator. Every main piece of equipment such as the water pump, motor convertor, servo-control, water pypass regulator, fuel pump, etc., should be tested for performance and capacity when overhauled before reapplying to steam generator. Several railroads are making up a test rack some of which has proven practical and beneficial, however, feel the manufacturer also has a certain responsibility in this development.

General improvements and some of the difficulties which have been prevalent during the past year are as follows:

1. The adoption and standardization of steel safety valves for eliminating leaks and to make their performance trouble-free.
2. Wiring of all steam generators for continuous running of the water pump has corrected much of the difficulty with burning of the line relays which were subjected to repeated momentary overloads and severe arcing due to repeated cycling, eliminated delayed spark and has practically stopped freeze-up in the water pump during cold weather, especially when one or more steam generators are being used and loading was not equalized, resulting in long OFF periods.
3. Application of belt tension adjustors, adjustable hinge type water pump base and magic grip pulleys, has done much to simplify and reduce repair time for proper vee belt adjustment.
4. The differential water by-pass control delay adapter, mechanical operation, simple in design and adjustment, controls or affects in a large way the smooth generator performance. Proper adjustment of this control makes possible igniting the steam generator with a minimum amount of fuel and air, preventing delayed combustion which sometimes happens with increased air adjustments, insures hot, clean fire and prevents water-logging of separator and carry-over into trainline. The servo-retarder has stopped the violent action of the servo when the steam generator is first turned on, promoting easier starting.

One criticism of the differential delay adapter is the short life of the differential pressure adjustment spring.

5. The latest remote control trainline shut-off valve with the inverted type bellows packing incorporating a metal umbrella protector, has been a vast improvement over any previous versions. Appears possible it can be maintained and will operate on long runs in transcontinental service as well as on shorter runs.
6. New style multiple serrated cam for stack switches in conjunction with proper adjustment of the servo-micro switch and differential delay adapter, has practically eliminated steam generator shut-down alarm failures.
7. On some of the older type CFK steam generators when stepping up the output, thus the speeding-up of the water pump, resulting in short packing life and some bearing difficulty. We have not been successful in the maintenance of this packing and appears a material and design change will be necessary.
8. Short vee belt life is still with us and has been very troublesome, especially in hot weather. It appears that a belt with high heat characteristics or possible wire inserts might be needed to correct this situation.
9. Motor convertors have been a source of much difficulty. Coil lead connectors to the terminal box, insulation cracking and deteriorating causing grounded or short circuited condition. Most of this difficulty can be corrected by applying a high-heat-resistant wiring and drilling hole in the terminal box for draining of condensation.

The motor conventor bearing performance has not been satisfactory. The introduction of the sealed bearing has probably contributed some to better performance but the present bearing used by the manufacturer has tended to pit and shell out, resulting in noisy bearings. The dust guard arrangement is flimsy and will not keep water or moisture out of the commutator end bearing, resulting in breakdown of the lubricant and failure. Periodic greasing tends to help this situation but is not the final answer.

10. Sticking of line relay contacts; although this trouble has abated due to the rewiring of the control circuits for continuous pump operation, it has not corrected the situation entirely and appears that the silver plated inserts tend to stick together even though the armature core has started its downward movement for drop-out.

Proper adustment of fuel nozzle and electrodes has always been more or less a trial and error proposition, with many different personal opinions involved rather than a predetermined setting that could be adjusted by a gauge. Variations in domes and fire pots made it impossible to set nozzle and electrodes as one complete unit. Proper height of nozzle in relation to fire pot and electrodes is important for igniting as well as for a hot, clean fire.

One road has applied, as test, two smoke-hood adapters with nozzles and electrodes as a complete unit with all adjustments made by a gauge before application and the spray tip remains in the same relation to the fire pot regardless what steam generator it is applied to. This appears to be an improvement developed

by the manufacturers which will do much for trouble-free operation and is worthy of consideration for standardizing on all the steam generators in service.

The report was prepared by a committee of which L. L. Luthey, general supervisor of Diesel engines, Atchison, Topeka & Santa Fe, was chairman.

Shop Tools for Locomotive Work

The repair and maintenance of injectors and fuel pumps is one of the most important and often the most expensive of locomotive parts. Some shops have attempted to repair injectors, with poor results. Before these parts can be successively repaired, some means of checking volumetric output, atomization, fuel pump calibration and pressure test must be available. A clean, dustproof room should be used if the best results are to be obtained. The test rack, shown in Figs. 1 and 2, is capable of testing E.M.D., Bosch and Bendix injectors and fuel pumps. One trouble commonly found to be causing fuel oil dilution on E.M.D. locomotives is leakage past the seal ring between injector body and nozzle. A leak in that spot is hard to locate in the absence of suitable testing equipment. For that reason, some means of placing the injector under pressure for several minutes is very desirable, as that is the only way to locate a leaky seal ring. The costs, in one shop, including overhead, for testing these injectors is only 20 per cent of the manufacturers' flat rate charges. The rack has a cam shaft with the same lift as that used on the various locomotives. The shaft is powered with an air motor operating at a speed of 125 r.p.m. Fuel oil is filtered after leaving the tank in much the same manner as is the case on all locomotives. A revolution counter is used, as a certain amount of atomized fuel is required per stroke. After the nozzle has been checked for atomization, a choke is placed over the nozzle tip and 40 revolutions of the machine is used as a standard for checking fuel output which is caught and measured in a calibrated vial. One railroad made a saving of $30,000 in one year by repairing injectors and pumps in its own shop. Another railroad reported a reduction of 50 per cent in fuel oil dilution after starting to repair injectors and fuel pumps. A pressure of 45 lb. should be placed on the low pressure side of the injector.

Fig. 1

Fig. 2

The maintenance of the lube oil pressure switch setting is of vital importance. Many crankshaft failures can be directly attributed to the malfunction of that part. Fig. 3 shows a small suction pump that is an effective means of checking a low oil pressure, as well as a lube oil suction switch. The pump has pressure on one side and suction on the other side. Gages placed in the line ahead of the switch being checked eliminated any possibility of improper setting; a properly functioning switch should pick up at 6 lb. and drop out at 9 lb. on E.M.D. engines. Pressure settings vary on other makes. It is advisable to seal the adjusting screw with sealing wax after setting, as enginemen sometimes adjust the switch to suit operating conditions, and switch setting is sometimes disturbed by vibration. The shop cost, including overhead, is about 20 per cent of the factory repair costs. The pump sells for 60 dollars.

Shop repair of oil cooler cores should be undertaken only when adequate washing and pressure test facilities are available. No doubt the graveyards are full of crankshafts put there by plugged oil cooler cores. Fig. 4 shows a core in the washing machine being cleaned. A plate covers one end of the core in much the same manner as used when pressure testing. An E.M.D. water pump driven by a 5-hp. electric motor, shown in Fig. 5, is used to force the cleaning solution through the core. The tank

Fig. 3

Fig. 4

is equipped with heating coils in order to keep solution at the proper temperature. A gage and pressure relief valve are in the line for protective purposes. Ordinarily the pressure runs at about 15 lb. if the core is not badly plugged; however, cores have been found that were completely plugged so that it was impossible to get cleaning solution through the core vanes. In

Fig. 5

Fig. 6

that case, the pressure will rise and it is necessary that a relief valve be in the line to prevent damage. Our shop costs, including overhead, are about 19 per cent of the factory repair costs.

The repair and maintenance of Vapor boiler water pumps can be simplified through the use of a test stand, such as shown in Fig. 6. The stand is used to measure the pump output after repair has been made. Any trouble that may exist in the valve arrangement shows up quickly on the stand. Many times a pump is condemned by the running side and removed from the engine only to find, after running on the test stand, that pump could very easily have been repaired on engine.

A 3-hp. motor is used with sheaves arranged to produce the same speed as that attained on the engine. The shop cost, including overhead, is about 20 per cent of the manufacturers' repair costs.

The removal of a No. 2 main air reservoir, used on E.M.D. locomotives, is a time-consuming operation and also a hazardous job. An angle iron arrangement is used that has proved an efficient method for removing and applying the drum. The car body cross member is used for fastening the inside of the tool while the outside legs slip over the frame shown in Fig. 7. There is an elevating screw to hold the drum in position while the retainer band nuts are being removed. After the bands are loosened, the elevating screw lowers the drum to the guide rails. After the drum is on the rails, it is necessary to rotate

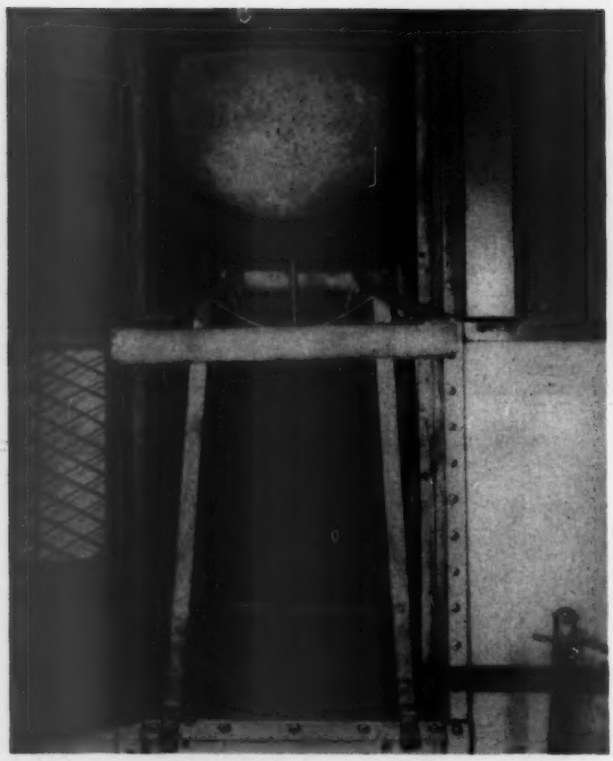


Fig. 7

leaving motors and wheels in place on fixture. Complete disassembly of a six-wheel truck can be performed in 1½ hours or less, while assembly time is about 2 hours. In a space approximately 20 ft. by 100 ft., 326 trucks have been rebuilt in 12 months, working five days per week. A truck can be removed from the locomotive and a motor changed in less time with this fixture than is required to change motor and wheels with a drop table.

Carbide Tools

Maximum results can be obtained with carbide tools only when used on machines with sufficient power and a wide range of speeds and feeds. One turning operation on which a substantial time saving can be made is a crank pin which is turned at 220 surface f.p.m., 11/16-in. depth of cut, and .030 inch feed per revolution. Pins of that kind are being produced in 29 min., floor-to-floor.

A check of results on wheel turning has also brought out that proper type dogs are very important. Wheels from machines using mechanical driving dogs have been checked and show out-of-parallelism between flanges .020 inch to .080 inch, hastening flange wear. Wheels from machines with hydraulic drivers check within .005 inch parallelism. While we cannot give a report of the effect on out-of-parallelism of Diesel wheels, it has been proven, on checking cars with a three-way ride meter, that the out-of-parallelism of car wheels was the direct cause of the car developing lateral weaving.

The use of carbide tools on a Man-Au-Trol boring mill has reduced machine time from about 4 hr. to 42 min. In addition to the saving in machine time, an additional saving of $6.00 a wheel was also made because of the fact that semi-balanced wheels are no longer purchased, as that operation is now accom-

Fig. 8

the drum into position for removal through the door. Placing tool in position requires about 10 min., and removing the drum from locomotive can be done in about 30 min. The ladder and crane ordinarily used in performing this operation is unsafe and also requires considerably more time.

The truck fixture, shown in Fig. 8, simplifies the operation of assembly and disassembly of trucks. Locating shoes are so arranged that the wheel centers of all makes of trucks are established by moving shoes to the dowels protruding from the outside of the rails. Two cross members are used for elevating the traction motor nose into position for spring removal. Wheeling is done by a single hook crane using a compensating sling arrangement. The truck frame is removed from motor and wheels,

plished in the boring mill. Another practice is the boring of all wheels for E.M.D. locomotives to print size, after which they are placed in stock—ready for application. Several hundred wheels have been machined and no fits lost. By having that set-up, when wheels from the pool come in for replacement, the only time required to get them back in service is press time.

The boring and turning of cylinder bushings has been reduced from 8¼ hr. to 5 hr. when high-speed tools were replaced with carbide.

Before machining operations can become effective, some means of providing the machine man with properly ground tools is an absolute necessity. Fig. 10 shows an inspection gage used for the purpose of checking tools for contour. All tool grinding

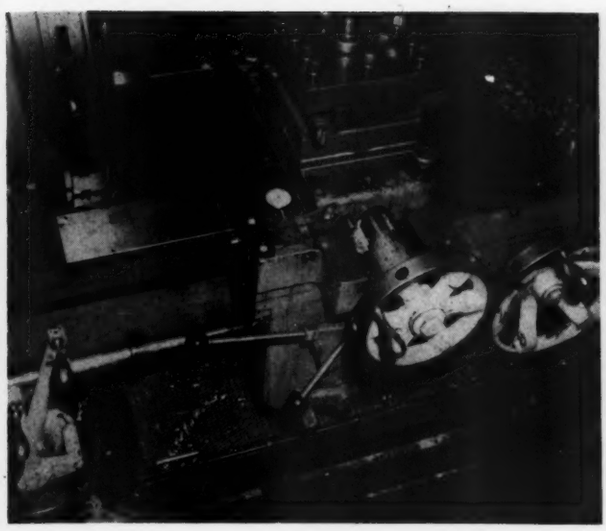


Fig. 9

operations are performed in a central grinding department where a force of six men handle the grinding of all cutting tools. One man is assigned to handle the wheel shop tools exclusively.

High speed and carbide axle turning tools are hand ground on two 14-inch Hammond carbide grinders—one for roughing, the other for finishing. These tools are ground manually. It has been found that the use of panagraph grinding attachments for machine tools has not been satisfactory, due to the time element per tool, accuracy in performing to the prescribed angles, and rakes. Also, with attachments of this type, the major part of the grinding is centralized at one point of the grinding wheel which reduces the life of the wheel.

All boring bar tools are ground on a boring bar machine, and are ground to a close tolerance.

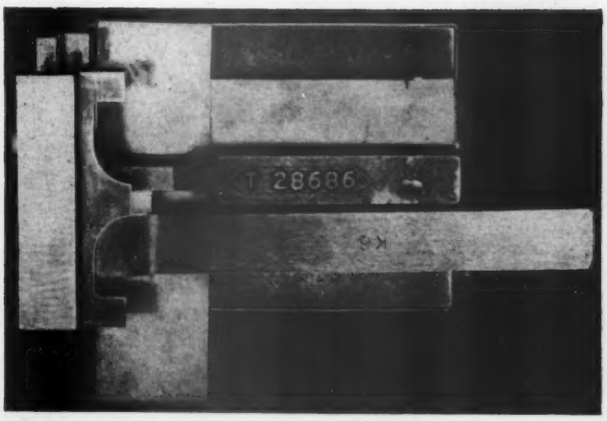


Fig. 10

The turning of the axle wheel fit to pre-determined size can be accomplished by the use of a dial indicator, as shown in Fig. 9. An actuating bar, attached to the machine cross slide, can be raised to permit burnishing or other operations that require excessive tool block movement. The indicator location is also movable relative to the actuating bar. It is necessary to move the indicator when changing the machine for different size axles. The turning of axles to known sizes enables the boring mill operators to bore without incessant changing of boring tools. No increase in the number of axles turned per day as the result of this method will be accomplished; it will, however, materially increase the boring mill output. Boring mill capacity can be used effectively, as it is then possible to bore different tape-sized for stock piling, knowing that they are machined and ready for mounting.

The report was prepared by a committee of which C. N. Rector, production engineer, Chicago & North Western, was chairman.

Terminal Facilities for Diesel Power

This report was presented in two parts, one having to do with terminal facilities for outlying points and the other with ventilation equipment for Diesel terminals. The facilities section dealt in detail with fuel servicing and heating equipment. The ventilation section is abstracted here.

Types of Ventilation in Diesel Shops

In some early Diesel shop installations an attempt was made to remove engine gases by installing exhaust fans in roof or wall ventilators. This arrangement met with little success, as the gases are heavier than air and while cooling fall to the floor almost immediately, except for the small percentage of them that rise to close proximity of the exhaust fans while they are still warm. Most of these ventilating systems were modified either by installing stacks to catch the gases or a series of exhaust fans connected to movable ducts that could be placed directly over the exhaust openings on the locomotive. These adjustable arrangements were reasonably workable by careful counterbalancing but were not used at all times due to their inconvenience, as it was necessary that someone get on top of the locomotive to apply and remove them from exhaust stacks.

Fig. 1 shows a simple arrangement in a building where seven active tracks are equipped with two stack type ventilators over each track. These stacks are 15 in. diam. and extend from approximately 6 in. above the locomotive exhaust stack to 4 ft. above the building roof. The bottom of the stack is provivded with a 45-deg. bell 25 in. in diameter and the top with an umbrella located 15 in. above the rim. It removes all of the gases emitted from a 1,000-hp. engine operated at full load without the aid of an exhaust fan. This arrangement, of course, is only workable where the locomotives are of the same type and can be spotted under the stacks during service periods.

A rather inexpensive method for removing gases has been

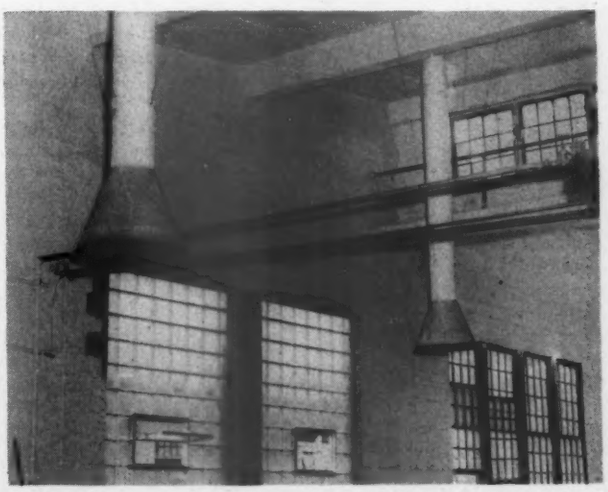


Fig. 1—Simple ventilating system for Diesel building that does not require use of exhaust fans

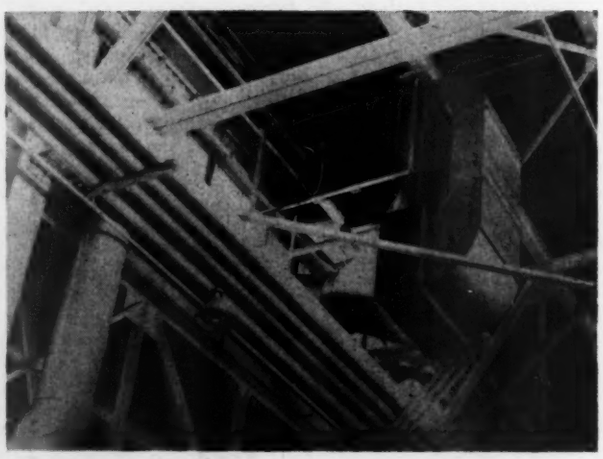
Fig. 2 (left): Exhaust gas duct and fan system in modern multiple unit Diesel building—Fig. 3 (below) Heating and ventilating system in Diesel building shown in Fig. 2

worked out by some roads when constructing new buildings by partitions put in the roof trusses so that sections of the ceiling form an exhaust duct. These ducts extend directly over the track and each section has an exhaust fan. In this manner the exhaust gases are confined to one portion of the overhead structure which acts like an exhaust duct placed over the stack.

The ventilation of shop buildings is a matter of considerable concern in a shop. One shop, for example, has a volume of 2,241,000 cu. ft. A comparatively inexpensive heating and ventilating system was installed for approximately $12,000. It consisted of 40,000 cu. ft. capacity fans to induce air into the building, which was heated by a large radiator in front of the fans. Fans of approximately the same capacity were installed to remove air from the shop, the intake fans being placed in the roof at the east end of the shop and the exhaust fans in the roof at the west end of the shop.

This system, while effective, is not a complete correction on cold winter days when the shop is closed up and when more than a couple engines are running. The State Board of Health investigated to see what harmful effects were present in gases in the shop. Tests for carbon monoxide showed the general air condition in the shop to contain less than 25 p.p.m., the exhaust gas directly over the exhaust stack to contain less than 100 p.p.m. and the air in the recirculating hot air system to contain less than 10 p.p.m. of this gas. The complete correction of this condition would entail expense out of reach for most of the larger Diesel shops and is not justified from a health standpoint; however, necessary improvements in ventilating systems should be made that are justifiably from an economic standpoint.

Figures 2 and 3 show a heating and ventilating system for a 100 ft. by 300 ft. shop building constructed recently to conform to orders, covering dust, fumes, vapor and gases, issued and enforced by the state of Wisconsin. To reduce contamination emitted in products of combustion of a given number of Diesel engines to a point below the concentrations in p.p.m., designated as harmful exposure required the introduction of outside air, tempered to meet code requirements. In this installation inlet air is introduced at roof truss height at 14 points, 7 along the north building wall and 7 along the south building wall, spaced 40 ft. apart. Air is drawn in by 14 fans having a capacity of 6,100 c.f.m. each or a total capacity of 85,400 c.f.m. Air from each fan is discharged through plenum chambers equipped with directional vanes through three 32 in. by 36 in. one row "non-freeze" coils and from thence to two 16 in. diameter discharge ducts terminating 2 ft. 0 in. above rail or nominal floor. Heating or tempering of the inlet air is accomplished by using the three coils described above which produce an inlet air temperature of approximately 80 deg. regardless of the outside temperature.



Steam is admitted to the first coil by a thermostat controlled valve when outside temperature falls to 50 deg.; to the second coil when the temperature reaches 30 deg., and to the third coil when the outside temperature falls to 10 deg. above zero. When ventilating system is not required fans are shut off and steam is automatically shut off to the second and third coils. The first coil is kept under steam to protect against possible freezing at sub-zero outside temperature, when ventilating system is not in use. Air is exhausted by exhaust system shown in Fig. 2 through narrow hoods having an opening 4 in. wide by 20 ft. long. There are eight of these hoods over each of the four tracks in this house. They are installed end to end, making an opening over each track approximately 160 ft. long or the length of a four unit locomotive. Each 20 ft. hood has four compartments through which air distribution is controlled by 4 in. by 15 in. dampers. Each hood is connected to a fan having a capacity of 2,800 c.f.m. by a 19 in. diameter duct section, and exhaust is discharged through discharge ducts equipped with weather heads through roof. The inlet of the 4 in. by 20 ft. hoods is flush with the bottom chord of the roof truss or approximately 24 ft. above rail. The total capacity of the exhaust system is 91,600 c.f.m. Inlet and exhaust units can be controlled individually or as a complete system. This heating and ventilating system was installed at a cost of approximately $40,000.

This report was presented by a committee of which H. E. Niksch, master mechanic, Elgin, Joliet & Eastern, was chairman.

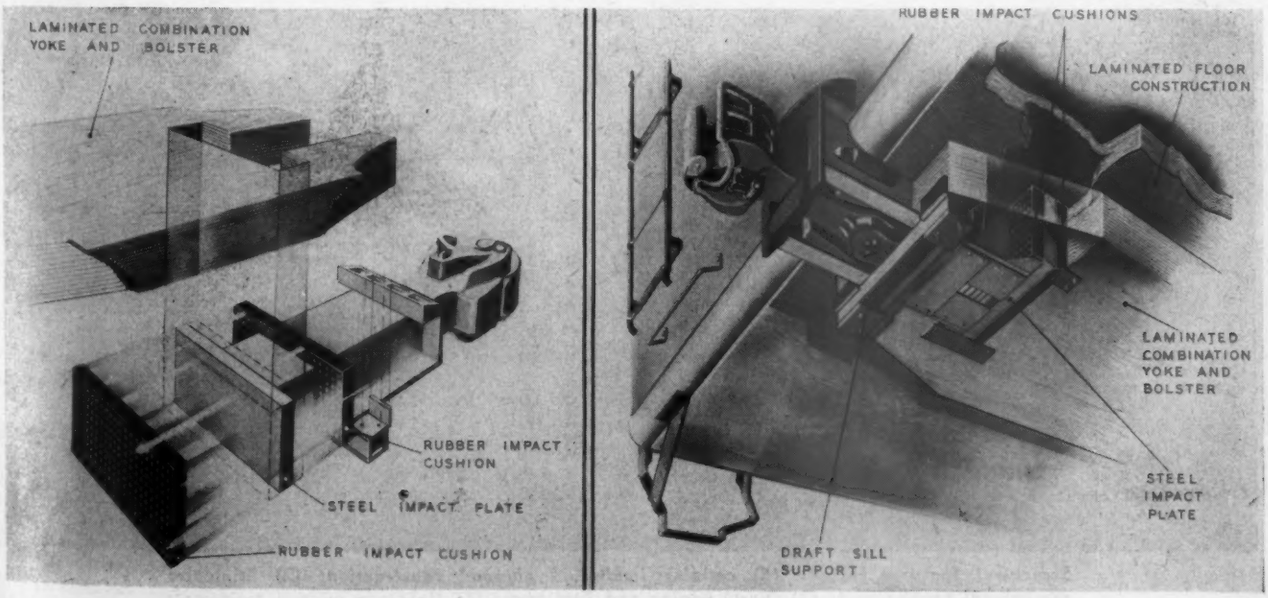
Exterior view of the Unicel 50-ton, 50½ ft. refrigerator-box car

Pressed Steel Develops Molded Car

In 1897, the Pressed Steel Car Company built what was probably the first all-steel railway car, a hopper type, for the Pittsburgh, Bessemer & Lake Erie and now, 53 years later, the Laminate Division of this company displayed at New York on October 16 a combination refrigerator-box car of revolutionary cellular-laminated plywood design in which essentially the only steel used is for the trucks, couplers, draft sills, door frames, brakes, safety appliances, etc. The surprising fact is that severe load and impact tests seem to show better resistance of this car to all stresses than is offered by conventional steel equipment.

The pilot model, with 50 tons nominal capacity and a light weight of 46,000 lb., was practically hand made, without tooling, from commercially available stock materials and has slightly different dimensions from subsequent production cars. The latter will be built utilizing a 1,000-ton press and high-frequency electric heating equipment to eliminate butt joints in the cellular laminated plywood construction, fabricate continuous panels and produce flush surfaces throughout at a further saving of about 6,000 lb. This light weight coupled with the restriction of metal parts in the car essentially to the trucks, couplers, the AB brake equipment, draft sills, door frames, safety appliances, etc., saves a large amount of steel which is then available for other national uses in an emergency.

Unicel cars are expected to offer the following advantages



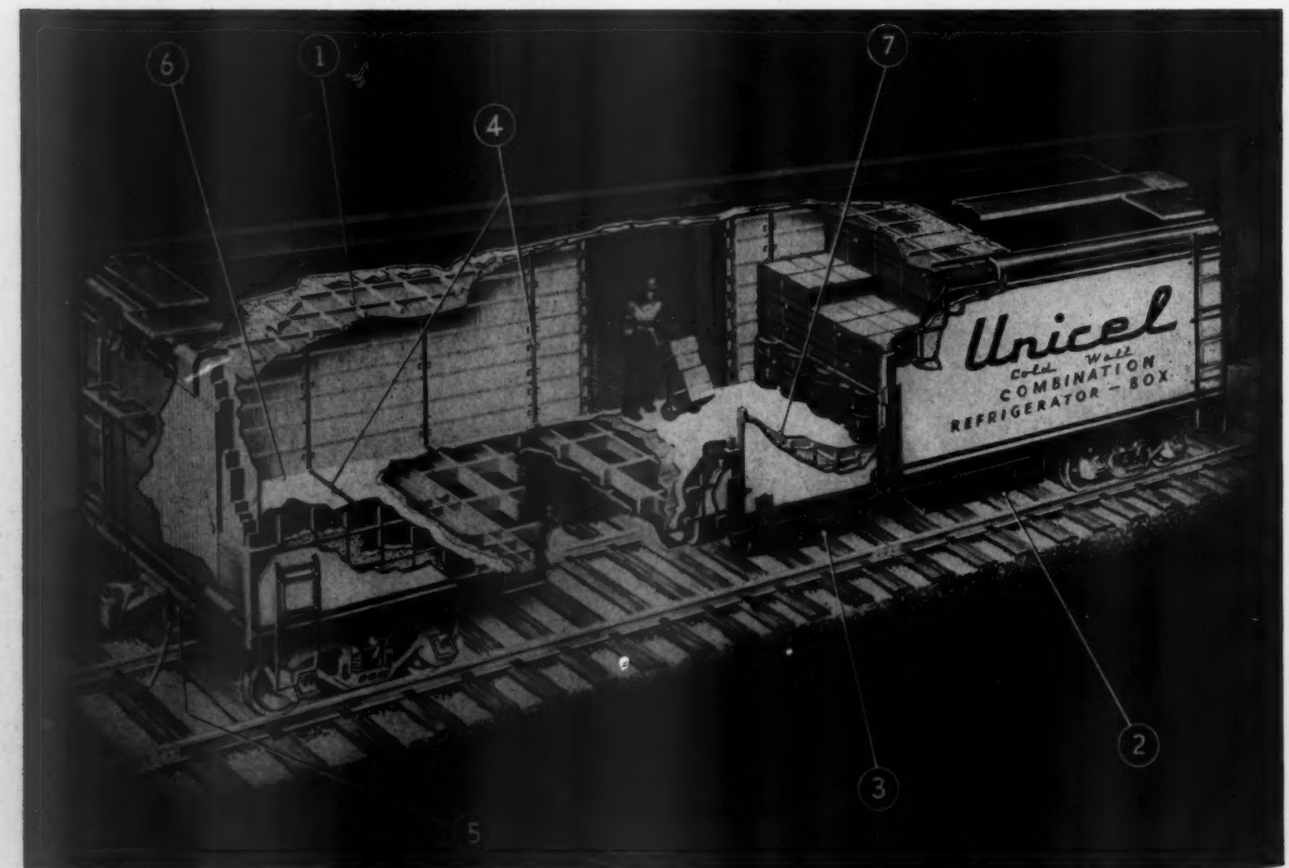
How the Unisorb draft-sill assembly is incorporated in the car structure

The laminated floor unit ready for application of sides, ends, and roof

over conventional cars: ability to carry a bigger payload when full; lighter to pull when empty; longer life; 20 tons less of critically needed steel per car; faster and easier to build; cheaper to operate and easier to clean and keep clean.

The basic Unicel box-car design is readily adapted to use as a refrigerator car utilizing the cold-wall construction of modern household refrigerators which, when applied in the floor, eliminates the need for floor racks. The cold wall forming all interior car surfaces is in addition to the inner and outer walls between which conductive and reflective type insulations are applied as required to limit conductivity of the overall construction to .07 B.t.u. per sq. ft. per hr. A Frigidaire mechanical refrigerating unit is installed, powered by a Diesel engine on the road and using plug-in electricity at sidings and warehouses

As a damage-reducing feature the car includes new Uni-strapping braces by means of which the lading is fastened securely to



Structural features include (1) cellular laminated plywood construction; (2) Frigidaire mechanical cooling unit; (3) Diesel engine and fuel tank; (4) Uni-strap built-in tie-downs; (5) Unisorb floating draft sill; (6) sanitary rounded corners; (7) smooth, flush car floor

IN THE DAYS WHEN FIRE-FIGHTING EQUIPMENT WAS DRAWN BY HORSES, NOT MUCH THOUGHT WAS GIVEN TO BOILER WATER CARRYOVER.

But, as fire-fighting equipment improved, progress was also made in locomotive boilers, always with the thought of efficiency, which must take into account the moisture content of the steam generated—for wet steam delivered to the superheater means lower temperature steam to the engine where work is performed and efficiency counts.

Regardless of design, the efficiency of any locomotive boiler and engine performance can be greatly improved by separation of the moisture in the steam leaving the boiler.

Research has dug deeply into the facts about Boiler Carryover and the results are contained in a paper that was presented before the American Society of Mechanical Engineers – *copy if you wish.*

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permanent, built-in tie-downs. The smooth, flush interior door and floor construction with rounded corners, can be easily cleaned.

Construction of the Car

The Unicel pilot car is a combination refrigerator-box car, and other conventional models will be produced as required. The car is designed for 250,000 lb. drawbar pull with a factor of safety of four and capable of withstanding at least 1,000,000 lb. in a pressure test with notably small deflection. There is no center sill, material normally concentrated in this sill being distributed to better advantage in outer walls where all load and impact shocks are absorbed. The car is essentially an interior and exterior double-wall stressed-skin structure, built according to the relatively new science of cellular laminates. Layer upon layer of specially chosen plywoods are mounted with grains crossed at various angles. The cells are formed by a frame of longitudinal and transverse wood members between the inner and outer skins, all of which are bonded together with special phenolic and resorcinol resins. In the refrigerator car the insulation is inserted in the cells before the parts are bonded. The core of the end is a solid assembly of two-by-four's placed side by side vertically and bonded together as well as to the inner and outer skins. The laminated car parts (the two side walls, the floor, the ceiling and the end walls) are joined by curved plywood corner members, the whole being actually molded into a one-piece structure, bonded together by means of dielectric heating. The one-piece car thus formed is designed to be stronger than a steel structure.

The car is built with 8-ft. by 9-ft. door openings where stresses are transferred to all-welded steel frames through special metal connectors. These frames are deeper and heavier sections than conventional door posts in order to absorb all shear and impact stresses with ample reserve strength. Sliding doors, of the same construction as the car sides, utilize Miner fixtures and are equipped with multi-step gasket seals in the case of refrigerator cars.

The Unicel structure is said to be superior in its resistance to heat transfer. The car is longer and has more usable cubic footage. Because of the inherent properties of the structure, it will tend to remain free of cracks on the inside.

Floating Draft Sill

While the Unicel stressed-skin construction tends to lessen the possibility of lading damage, some way was sought to reduce even more the shocks which occur in any car structure while it is being pushed and pulled over the rails, shortening considerably the life of the car and increasing the frequency and necessity of repairs. The Unisorb floating draft sill, designed for this purpose, is constructed so it is free to move when pulled or buffed. The sill itself is contained within a strong laminated bolster yoke molded integral with the car body.

The impact steel plate which forms the end of the sill is sandwiched between special durable rubber mounts, each three inches thick. Both in pull and buff, the end steel plate transmits forces to the bolster through its rubber mount medium. The laminated bolster and steel plates are never in contact. This means that the forces that flow into the car are cushioned at the point where they are delivered to the car structure. The floating draft sill houses a rubber cushion draft gear assembly. The coupler travel in either buff or pull is about 1¼ in. for the draft sill and 2¾ in. for the draft gear, or a total of 4 in. of rubber-cushioned movement. This additional protection, in connection with modern, high-speed trucks and the method of load securement is expected to effect a substantial reduction in the freight claim bill.

Car Design Thoroughly Tested

The Unicel car design has been thoroughly tested for physical strength by an independent agency, the Armour Research Foundation, with official observers from the Association of American Railroads Mechanical Division. Extensive refrigeration tests have also been conducted with instrumentation approved by the A.A.R. While final test reports are not yet available, the results appear generally favorable and indicate definite promise for the future. In the horizontal impact tests, for example, runs have been made up to 12½ m.p.h., which is equivalent to a sill pressure of approximately 800,000 lb., with no signs of distress or failure in the new car structure. The conventional hammer car which, like the Unicel car, was fully loaded and free to move on the rails, on the other hand, developed a 3-in. bulge in the steel car end and other associated damage.

The Unicel production car will have a finish of plastic overlay thoroughly bonded to the plywood panels using heat and pressure and giving a finish impervious to salt, acid or chemical reaction, outside or inside.

It is expected that minimum repair work of any kind will be required. In case a side wall is accidentally punctured, the defective part may be easily cut out back to the cellular core, the damaged core replaced, if necessary, and a new plywood panel section of the desired size applied, using a waterproof glue or adhesive under nail pressure with no heat. Plastic overlay can be applied in liquid form with a brush or trowel on end-grain or repaired plywood sheets and air dried to give the desired finish.

Commonwealth B-X Type Truck

The General Steel Castings Corporation has recently developed an improved Commonwealth four-wheel, B-X type truck for commodity cars operating in passenger train service. This new lightweight truck is now in service on several leading railroads, including the Pennsylvania, the Missouri Pacific and the Baltimore & Ohio, and is said to have demonstrated important advantages in recent tests.

This truck differs greatly from the freight-car type of truck used on many box-express cars, as its design incorporates basic proven principles of the passenger-car type of truck, yet it has been simplified so that the wheel base is no longer than that of a standard freight-car truck.

The one-piece cast steel truck frame with cross transoms and machined integral pedestals holds the axles in tram at all times. The one-piece cast steel bolster is supported on swing hangers, providing lateral control. Separate equalizers plus increased spring capacity give better riding with less damage to car contents, car body, and track.

The truck may be arranged for either clasp brakes or the single-shoe type of brakes, and for either roller or plain bearings. The truck is also arranged for locking center pin so that in case of derailment the truck remains attached to the car, following passenger car practice. By the use of truck the expense of maintaining car body and truck is greatly reduced, and the pos-

Close-up view of the new four-wheel box-express car truck equipped with single brakes

600 H.P.—100 ton—for medium and light-duty switching.

800 H.P.—115 ton—handles jobs ordinarily assigned to 1000 H.P. units.

1200 H.P.—125 ton—a 20% increase in horsepower—faster speed—greater work capacity.

1500 H.P.—125 ton—for local freight, local passenger, mixed trains, yard humping, transfer work and other difficult jobs.

2400 H.P.—250 ton—for transfer service and humping.

3600 H.P.—375 ton—for the heaviest assignments, in humping, mining and other rugged work.

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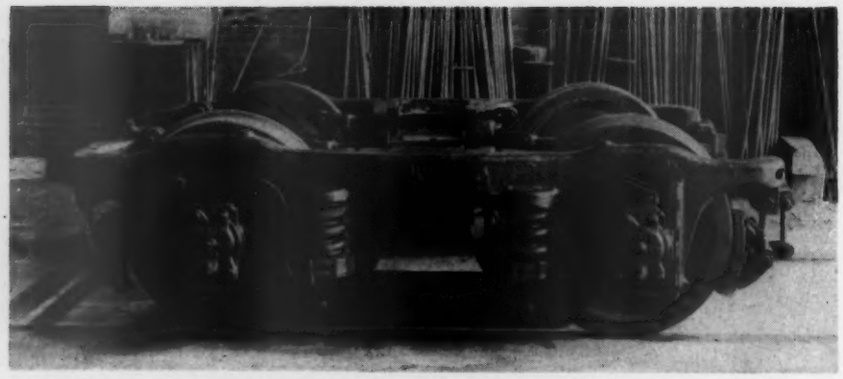


Commonwealth four-wheel B-X truck equipped with roller bearings and clasp brakes

sibility of derailment is lessened because of its swing motion and equalization features.

This new Commonwealth truck has been especially designed to meet the demand for a safe, rugged, practical, lightweight truck for box-express cars operating in passenger train service.

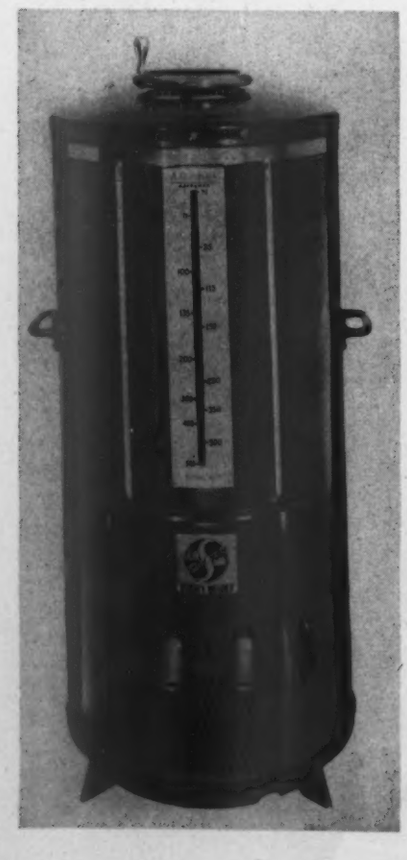
400-Amp. A.C. Welder

A 400-amp. welding transformer Model, 400E, has gone into production at A. O. Smith Corporation, Milwaukee, Wisc. It combines features of low initial cost and easy maintenanee and operation, with a welding range of 70 to 585 amp.

Rated in accordance with N.E.M.A. specifications, 400 amp. at 60 per cent duty cycle, it retains the full 75-volt open circuit voltage

Fan motor and capacitors are easily accessible for maintenance through the hinged door at the front of the machine. An industrial type heavy-duty motor-driven fan provides high velocity air to clean and cool the coils. Commercially available secondary connectors are standard equipment.

Other features include primary connections mounted in a standard knock-out box for simple installation, and a patented ball bearing coil-moving screw for easy adjustment.



Compact, Lightweight Fuel Injection Pump

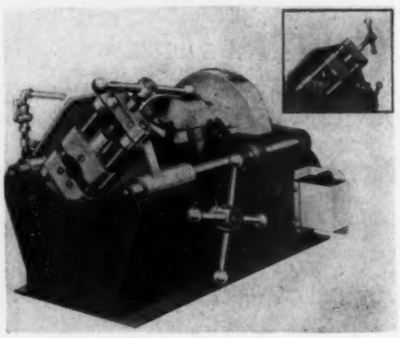
Design of the illustrated double disc pump, known as the model DD, enables unit replacement of the fuel pressure pumps, distributor discs, and governor assembly without removal of the pump from the machine or engine. This fuel pump is 65 per cent lighter and 56 per cent smaller than previous models. It has been introduced by the Cummins Engine Co., Inc., Columbus, Ind. The lighter weight and smaller size facilitates the installation and servicing of the pump used for automotive and stationary applications and further reduces the overall weight of Cummins Diesels.

The device is now offered as standard equipment on the 300 hp. model NHRS-600 and 275 hp. model NHS-600 Diesels and is also available as optional equipment on other Cummins models. A tandem arrangement of the pump is standard on the 12 cylinder, 400 hp. model NVH-1200 and 500 hp. model NVHS-1200 engines.

Reciprocating parts are lighter in weight in the DD unit which contributes to stress on the governor and throttle linkage. greater service life. Needle bearings are used in all possible operating parts. Wear on bushings and bearings is largely eliminated because of a reduction of angular stress on the governor and throttle linkage.

Power Pipe Machine Wheel Cut-Off

A choice of either wheel or roller cut-off or knife cut-off is now offered on the No. 999 Super Model 2 in. Power Pipe machine manufactured by the Toledo Pipe Threading Machine Co., Toledo, Ohio. With the wheel cut-off, the cutter head is equipped with two rollers and one cutter wheel which is self-aligning and centering and



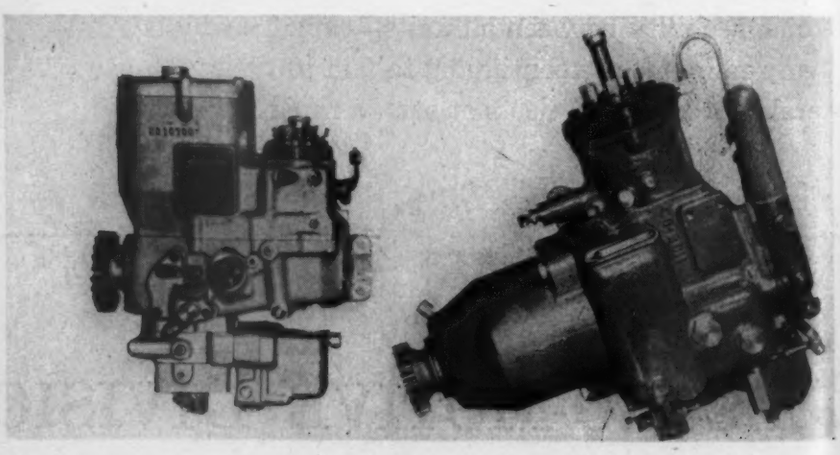
easily fed with a hand wheel. This device cuts off pipe rapidly, leaving a clean cut.

If a knife cut-off is preferred, the machine is furnished with four cutter knives which leave a straight square-end cut without burr. Blades are fed through a scroll by a small hand wheel, and may be resharpened many times.

Cutting is rapid with either type of cut-off, cutting off 2 in. pipe in 10 seconds. The unit, which has quick-opening die heads, threads 2 in. pipe in 22 seconds. A convenient thread gauge shows the length of the thread being cut.

Production with the machine is high because of instant change from cutting to thearding and vice versa, quick change of die heads, no rear chucking, high speed cutting and threading. A 12 tooth cone type fluted reamer on the arms swing quickly into position for reaming. Thread-

(*Continued on page 712*)



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NEWS

Emergency Specifications Approved

The General Committee of the A.A.R. Mechanical Division has approved emergency specifications "in order to provide for an improved product in both waste and oil for use in the lubrication of journal bearings on freight cars." The specifications are to be met not later than January 1, 1951, and will apply to free oil as well as to the oil used in preparing packing. The new specifications have been prepared by a joint sub-committee representing the Committee on Lubrication of Cars and Locomotives and the Committee on Specifications for Materials to supersede the present standard and will remain in effect until such time as the Mechanical Division research on these materials has been completed.

As a further means of improving journal lubrication, the Arbitration Committee has been instructed to modify Interchange Rule 66(a), effective January 1, 1951, for one year, reducing the present 15-month period for repacking journal boxes to 12 months and authorizing receiving lines to reject empty foreign cars when delivered by owners with repack dates more than 15 months old.

The Board of Directors of the association has authorized an increase in personnel of the Mechanical Inspection Department and the additional inspectors are already in the field busily engaged in checking lubrication practices, materials and results. In all cases where practices do not conform to desired standards, corrective action is taken insofar as practicable on the spot in order to effect necessary improvements with a minimum of delay and red tape.

Proposes to Revise Diesel Brake Rule

Division 3 of the Interstate Commerce Commission has issued a notice setting out a proposal to revise Rule 205(a) of the commission's Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam. The rule involved relates to air-brake equipment, and the proposed revision will be handled by the commission in a proceeding docketed as Ex Parte No. 174.

The rule "tentatively proposed" as a substitute for the present rule was given in the notice as follows:

205.(a) The main reservoir systems of each unit shall be equipped with at least one safety valve, the capacity of which shall be sufficient to prevent an accumulation of pressure of more than 10 lb. per sq. in. above the maximum working air pressure fixed by the chief mechanical officer of the carrier operating the locomotive.

Each unit that has a pneumatically actuated system of power controls shall be equipped with a separate reservoir of air under pressure to be used for operating such controls, other than brake controls, which reservoir shall be provided with means to automatically prevent loss of pressure in event of failure of main reservoir air pressure, shall have storage capacity to permit not less than 3 complete operating cycles of control equipment and shall be so located that it will not be readily susceptible to damage. Each unit built before January 1, 1951, that has a pneumaticically actuated control system of power control shall be so equipped the first time said unit receives repairs of a general nature after January 1, 1951, but not later than January 1, 1952.

The proposed change is the addition of the second paragraph, the first paragraph of the foregoing being the present rule. The commission's notice said that the revision was being proposed upon recommendation of the director of its Bureau of Locomotive Inspection, Edward H. Davidson.

SELECTED MOTIVE POWER AND CAR PERFORMANCE STATISTICS

Freight Service (Data from I.C.C. M-211 and M-240)

Item No.		Month of June 1950	Month of June 1949	6 months ended with June 1950	6 months ended with June 1949
3	Road locomotive miles (000) (M-211):				
3-05	Total, steam	29,128	32,728	165,348	211,263
3-06	Total, Diesel-electric	17,010	12,449	97,696	69,702
3-07	Total, electric	826	796	4,843	5,044
3-04	Total, locomotive-miles	47,054	45,973	267,911	286,011
4	Car-miles (000,000) (M-211):				
4-03	Loaded, total	1,638	1,504	9,040	9,028
4-06	Empty, total	865	876	4,904	5,238
6	Gross ton-miles-cars, contents and cabooses (000,000) (M-211):				
6-01	Total in coal-burning steam locomotive trains	48,949	52,392	268,252	335,646
6-02	Total in oil-burning steam locomotive trains	14,366	16,369	70,249	91,140
6-03	Total in Diesel-electric locomotive trains	48,502	35,647	275,105	199,737
6-04	Total in electric locomotive trains	2,203	2,201	12,679	13,694
6-06	Total in all trains	114,025	106,615	626,395	640,253
10	Averages per train-mile (excluding light trains) (M-211):				
10-01	Locomotive-miles (principal and helper)	1.05	1.06	1.05	1.06
10-02	Loaded freight car-miles	39.00	36.80	37.70	35.60
10-03	Empty freight car-miles	20.50	21.50	20.40	20.70
10-04	Total freight car-miles (exrluding caboose)	59.50	58.30	58.10	56.30
10-05	Gross ton-miles (excluding locomotive and tender)	2,713	2,613	2,611	2,527
10-06	Net ton-miles	1,234	1,176	1,175	1,149
12	Net ton-miles per loaded car-mile (M-211)	31.70	31.90	31.20	32.20
13	Car-mile ratios (M-211):				
13-03	Per cent loaded of total freight car-miles	65.40	63.20	64.80	63.30
14	Averages per train hour (M-211):				
14-01	Train miles	16.90	16.90	17.00	16.80
14-02	Gross ton-miles (excluding locomotive and tender)	45,329	43,698	43,805	42,026
14	Car-miles per freight car day (M-240):				
14-01	Serviceable	46.80	43.20	43.30	42.60
14-02	All	43.80	40.70	40.30	40.40
15	Average net ton-miles per freight car-day (000) (M-240)	907	821	814	825
17	Per cent of home cars of total freight cars on the line (M-240)	39.60	52.10	45.40	50.20

Passenger Service (Data from I.C.C. M-213)

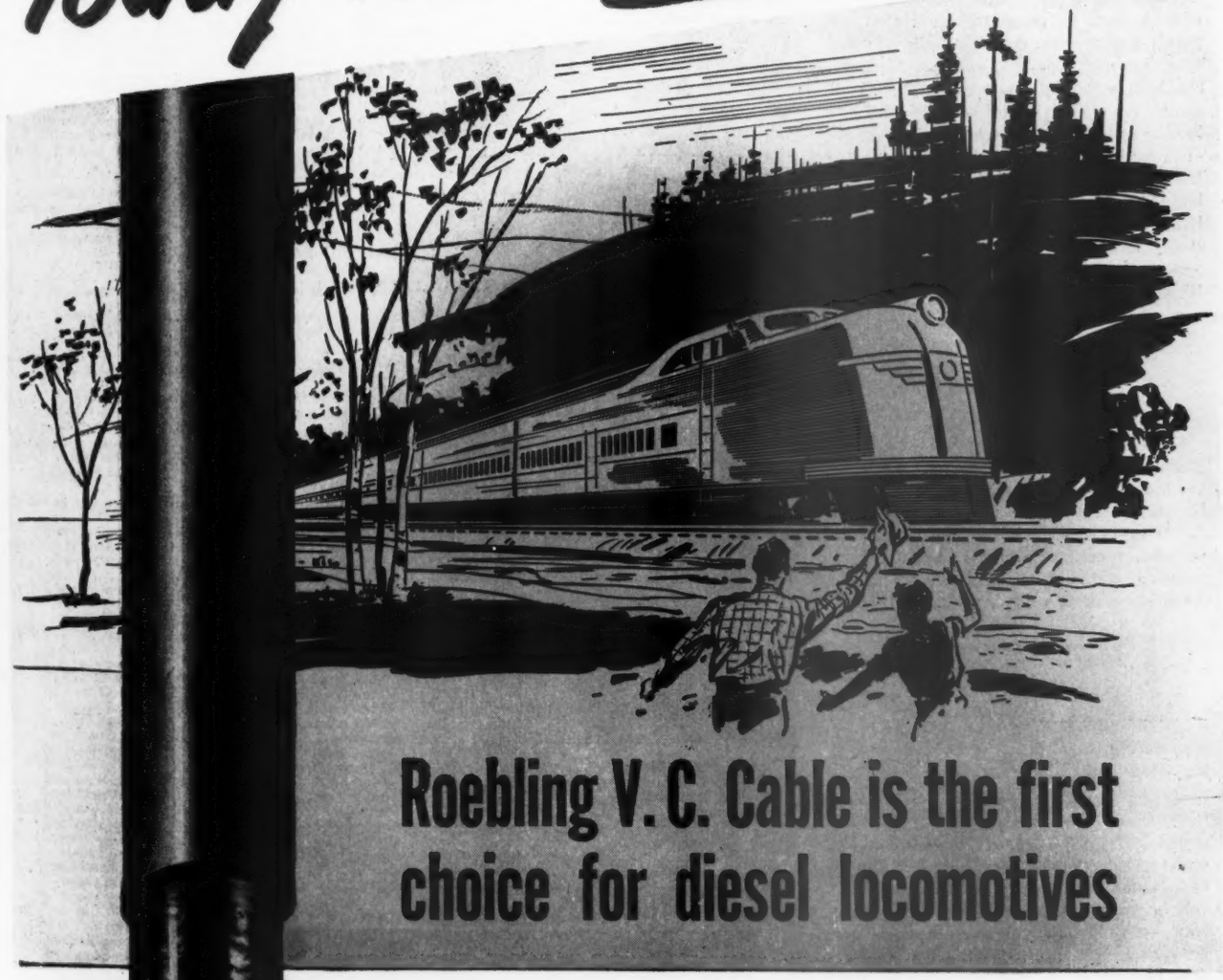
3	Road motive-power miles (000):				
3-05	Steam	12,214	15,146	68,236	99,105
3-06	Diesel-electric	14,404	12,961	84,322	72,492
3-07	Electric	1,608	1,608	9,518	10,083
3-04	Total	28,226	29,730	163,076	181,789
4	Passenger-train car-miles (000):				
4-08	Total in all locomotive-propelled trains	271,043	281,547	1,552,578	1,683,240
4-09	Total in coal-burning steam locomotive trains	63,968	78,140	346,987	522,571
4-10	Total in oil-burning steam locomotive trains	38,487	46,074	210,325	264,459
4-11	Total in Diesel-electric locomotive trains	151,703	139,901	892,371	785,324
12	Total car-miles per train-miles	9.47	9.26	9.35	9.08

Yard Service (Data from I.C.C. M-215)

1	Freight yard switching locomotive-hours (000):				
1-01	Steam, coal-burning	1,396	1,710	8,342	11,735
1-02	Steam, oil-burning	255	273	1,363	1,750
1-03	Diesel-electric[1]	2,473	1,987	14,132	11,459
1-06	Total	4,151	3,995	23,994	25,103
2	Passenger yard switching hours (000):				
2-01	Steam, coal-burning	57	86	364	594
2-02	Steam, oil-burning	13	15	77	98
2-03	Diesel-electric[1]	227	206	1,331	1,212
2-06	Total	330	341	1,974	2,113
3	Hours per yard locomotive-day:				
3-01	Steam	8.20	8.00	7.60	8.70
3-02	Diesel-electric	17.60	17.50	17.30	17.60
3-05	Serviceable	14.20	13.20	13.80	13.40
3-06	All locomotives(serviceable, unserviceable and stored)	12.10	11.10	11.50	11.50
4	Yard and train-switching locomotive-miles per 100 loaded freight car-miles	1.76	1.84	1.83	1.9
5	Yard and train-switching locomotive-miles per 100 passenger train car-miles (with locomotives)	0.76	0.75	0.79	0.7

[1] Excludes B and trailing A units.

Today it's Roebling!



Roebling V.C. Cable is the first choice for diesel locomotives

ELECTRICAL CABLES for diesel locomotives must be able to withstand high temperatures . . . degrees of heat that would soon cause failure in ordinary cables. Roebling points with pride to the fact that Roebling Varnished Cambric Cable meets this requirement with complete dependability. In addition, it is built with a high safety factor that takes most overloads. On the basis of proven performance Roebling V.C. is today's A-1 specification with manufacturers of diesel locomotives!

And there is similar efficiency and long-run economy in Roebling's other electrical wires and cables that serve in the transportation field . . . Signal Cable and Cab Cable with ROEPRENE jackets . . . Jumper Cables and Control Cables . . . Hard drawn bare copper wire, with or without weather-resistant covering . . . Trolley wire and a complete line of Magnet Wire.

Write for full information about any or all of these quality wires and cables.

ROEBLING

A CENTURY OF CONFIDENCE

Atlanta, 934 Avon Ave. ★ *Boston*, 51 Sleeper St. ★ *Chicago*, 5525 W. Roosevelt Road ★ *Cincinnati*, 3253 Fredonia Ave. ★ *Cleveland*, 701 St. Clair Ave., N. E. ★ *Denver*, 4801 Jackson St. ★ *Houston*, 6216 Navigation Blvd. ★ *Los Angeles*, 216 S. Alameda St. ★ *New York*, 19 Rector St. ★ *Philadelphia*, 12 S. Twelfth St. ★ *Portland*, 1032 N. W. 14th Ave. ★ *San Francisco*, 1740 Seventeenth St. ★ *Seattle*, 900 First Avenue S.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON 2, NEW JERSEY

"In recent months," the notice also said, "there have been accidents in which the unit of a locomotive other than steam had its brake system put out of commission by the loss of main reservoir air pressure and the locomotive unit, which had become disconnected, proceeded down the track out of control."

The notice advised that the commission will conduct an investigation of the proposal; and receive, from the railroads and other interested parties, evidence "in written form with affidavits attached." Verified statements embodying evidence-in-chief will be due on or before November 15; notices of objections to such evidence will be due December 1; and statements embodying rebuttal evidence will be due December 15. If cross-examination of a witness is desired, written request therefor must be given to the secretary of the commission, W. P. Bartel, and to the witness or his counsel, on or before January 1, 1951.

A.R.C.I. Elects New President

CHARLES W. WRIGHT, president of the Pullman-Standard Car Export Corporation, has been elected president of the American Railway Car Institute to succeed *Samuel L. Felton*, who resigned to accept the presidency of the Shippers' Car Line Corporation, a wholly owned subsidiary of the American Car & Foundry Co.

A.S.M.E. Annual Meeting

New researches, applications and operations on current developments within the engineering profession will be discussed at the 83rd annual meeting sessions of the American Society of Mechanical Engineers to be held at the Hotel Statler, New York, November 26 to December 1, inclusive. Simultaneously, the National Power Show, now under the auspices of the A.S.M.E., will be held at the Grand Central Palace, New York. The annual banquet of the society is scheduled for 6:30 p.m., Wednesday, November 28. The program, in part, is as follows:

TUESDAY, NOVEMBER 28

9:30 a.m.

Railroad (I)—Materials Handling (I)

Symposium: Development of Special Freight Cars Designed for Protection of Lading

Design Features of the General American-Evans "Damage-Free" Box Car, by R. M. Lamport, assistant vice-president, General American Transportation Corporation.

Special Loading Cars in Automotive-Parts Service, by F. W. Hess, general car and loading inspector, Chesapeake & Ohio.

2:30 p.m.

Railroad (II)—Fuels (I)

Symposium on Performance Experience with Double-Screened Locomotive Fuel

Speakers:

John S. Swan, fuel-conservation engineer,

ORDERS AND INQUIRIES FOR NEW EQUIPMENT PLACED SINCE THE CLOSING OF THE SEPTEMBER ISSUE

DIESEL LOCOMOTIVE WORKS

Road	*No. of units*	*Horsepower*	*Service*	*Builder*
Canadian National	4A[1]	1,600	Road	Montreal Loco. Works
	4B[1]	1,600	Road	Montreal Loco. Works
	18	1,000	Road switch	Canadian Loco. Co.
Missouri-Kansas-Texas	4	2,500	Passenger	Alco-G. E.
	6	1,600	Road switch	Alco-G. E.
	10	1,500	Road switch	Electro-Motive
New York Central	34A[2]	1,500	Road freight	Electro-Motive
	4A[2]	2,250	Road pass.	Electro-Motive
	20[2]	1,200	Yard switch	Electro-Motive
	2A[3]	1,600	Road freight	Alco-G. E.
	10B[2]	1,600	Road freight	Alco-G. E.
	50[3]	1,600	Road switch	Alco-G. E.
	50[3]	1,500	Road switch	Electro-Motive
	13[2]	1,600	Road switch	Fairbanks-Morse
	17[2]	1,200	Road switch	Lima-Hamilton
Reading	10[3]	1,600	Road switch	Baldwin Loco. Works
	10[3]	1,600	Road switch	Alco-G. E.
Southern Pacific	22	1,200	Switch	Baldwin Loco. Works
	10	1,600	General purpose	Baldwin Loco. Works
	8	1,600	Road	Baldwin Loco. Works
	10	660	Switch	Alco-G. E.
Terminal Railroad Assn. of St. Louis	6	1,200	Switch	Lima-Hamilton Corp.
	4	1,600	Road switch	Alco-G. E.

DIESEL LOCOMOTIVE LEASES

Baltimore & Ohio	86[4]	1,500	Freight	Electro-Motive
	4[4]	2,250	Passenger	Electro-Motive

FREIGHT-CAR ORDERS

Road	*No. of cars*	*Type of car*	*Builder*
Akron, Canton & Youngstown	50	70-ton covered hopper	Greenville Steel Car
Baltimore & Ohio	1,000[5]	50-ton box	American Car & Fdry.
	20[5]	50-ton automobile	American Car & Fdry.
Canadian National	2,000[6]	50-ton box	Canadian Car & Fdry.
	1,500[6]	50-ton box	National Steel Car
	1,500[6]	50-ton box	Eastern Car
Chesapeake & Ohio	1,000[7]	70-ton hopper	American Car & Fdry.
Chicago & Eastern Illinois	25	Flat	Thrall Car
Chicago & North Western	2,000	50-ton box	Pullman-Standard
Chicago, Indianapolis & Louisville	100	50-ft. box	General American Trans.
Delaware & Hudson	1,000[8]	50-ton hopper	Bethlehem Steel
Denver & Rio Grande Western	500	50-ton hopper	Pressed Steel Car
	25	70-ton covered hopper	American Car & Fdry.
	50	50-ton flat	Company shops
Great Northern	3	Well-type flat	Company shops
	250[9]	70-ton gondola	American Car & Fdry.
Illinois Central	1,000	50-ton box	Company shops
	120	70-ton covered hopper	American Car & Fdry.
Lancaster & Chester	20	50-ton box	Pullman-Standard
Louisville & Nashville	1,000	50-ton box	Pullman-Standard
Minneapolis, St. Paul & Sault Ste. Marie	400	50-ton box	Company shops
	100	50-ton hopper	Company shops
Missouri-Kansas-Texas	500	50-ton box	Pressed Steel Car
	300	70-ton gondola	Pullman-Standard
Missouri Pacific Lines	500[10]	70-ton gondola	Company shops
New York Central	1,000[11]	55-ton box	Pullman-Standard
Norfolk & Western	500	50-ton box	Pullman-Standard
Pennsylvania	1,200[12]	Gondola	American Car & Fdry.
	800[12]	Gondola	Pullman-Standard
	500[12]	Gondola	General American Trans.
	250[12]	Gondola	Company shops
	1,500[12]	Box	Pressed Steel Car
	500[12]	Box	Company shops
	250[12]	Flat	Company shops
St. Louis & Belleville Electric	50	70-ton hopper	American Car & Fdry.
St. Louis-Southwestern	25	70-ton hopper	American Car & Fdry.
Southern	2,000[13]	50-ton box	Pullman-Standard
Southern Pacific	1,600	500-ton box	Pullman-Standard
	1,900	Box	American Car & Fdry.; Pullman-Standard, and company shops
	1,100	Gondola	
	100	Hopper	
	250	Covered hopper	
	50	Caboose	
Spokane, Portland & Seattle	200[14]	70-ton gondola	American Car & Fdry.

FREIGHT-CAR INQUIRIES

Atlantic Coast Line	800	50-ton gondola	
	100	50 or 70-ton gondola	
	100	50-ton hopper	
Baltimore & Ohio	500–2,000	50-ton hopper	
Elgin, Joliet & Eastern	300	50-ton hopper	
	100	70-ton hopper	
	500	50-ton gondola	
	100	70-ton gondola	
Spokane, Portland & Seattle	200	50-ton flat	
Union Pacific	500	70-ton covered hopper	
Texas & Pacific	150	Gondola	
	250	Hopper	
	100	Covered hopper	
	100	Flat	
	200	Box	

PASSENGER-CAR ORDERS

Road	*No. of cars*	*Type of car*	*Builder*
New York, Susquehanna & Western	4	Rail Diesel	Budd Company

[1] The eight A and B units will cost about $1,500,000. Deliveries scheduled for early next year.
[2] Deliveries scheduled to begin in the first quarter of 1951.
[3] Deliveries expected early in 1951.
[4] To be leased from the Equitable Life Assurance Society. Early delivery expected on passenger units. Deliveries of freight units to begin this month and to be completed by June, 1951.

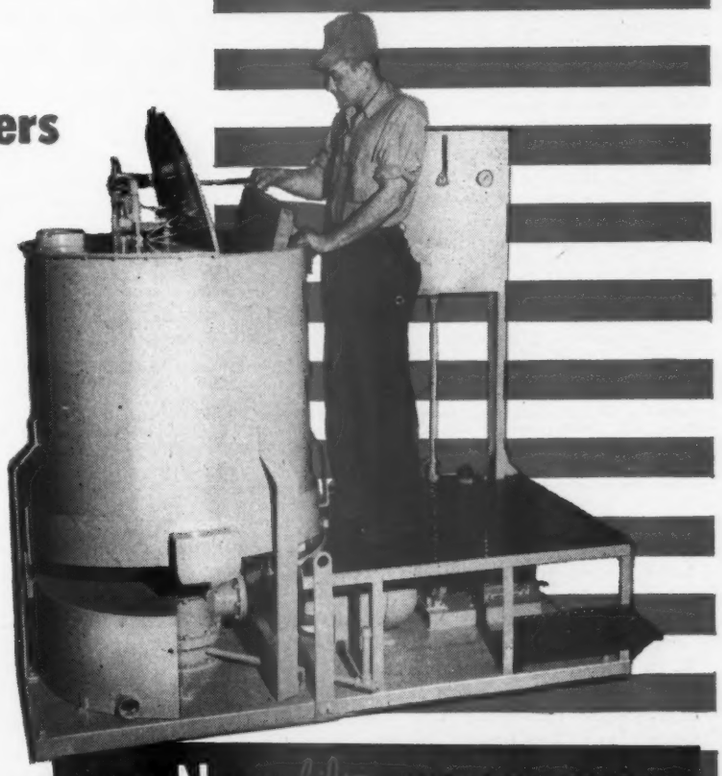
(*Continued on page 703*)

Oil and Water Do Not Mix!

We Like Oiling Dry Filters

Purchasers of the SAFE-N-EZY Air Filter WASHER-OILER:

Atlantic Coast Line Railroad
Baltimore & Ohio Railroad Co.
Bessemer & Lake Erie Railroad
Chicago, Burlington & Quincy
Chicago & North Western Railway Co.
Chicago, St. Paul, Minneapolis & Omaha Railway
Great Northern Railway Co.
Missouri Pacific Railroad Co.
Nashville, Chattanooga & St. Louis
The Pennsylvania Railroad Co.
St. Louis-San Francisco Railway Co.
Seaboard Air Line Railroad
St. Louis Southwestern Railway Co.
Texas & Pacific Railway Co.
Washington Terminal Company
Wabash Railroad Company



SAFE-N-EZY filter WASHER-OILER

FAST...THOROUGH...ECONOMICAL

COMPACT...A SINGLE PACKAGED UNIT

SIMPLE, ONE-MAN OPERATION

Filters must be properly oiled to assure maximum operating efficiency of diesel engines and air conditioning equipment. For thorough oiling by any method we believe the filter should first be dry — if the job's to be done right.

The SAFE-N-EZY Filter WASHER-OILER thoroughly cleans and oils standard size permanent type locomotive and passenger car air filters at high speed. Unusual compactness — 6'10" x 4'6" of floor space — permits convenient installation in existing service plants.

Centrifugal action spins filters dry and assures thorough, even oiling. Design of the Washer-Oiler provides for complete control of the cleaning cycle to suit condition of each load of filters.

The SAFE-N-EZY Filter WASHER-OILER is a complete packaged unit which does the entire job of thorough cleaning and oiling in one machine . . . by one man . . . in one handling.

More and more railroads are now using this faster, more efficient, less expensive method of air filter maintenance. The unbelievably low price of this new unit makes possible rapid amortization of the investment through drastic reduction of filter maintenance costs.

Get the details now on how the new SAFE-N-EZY Filter WASHER-OILER can go to work for you . . . saving money on filter maintenance and improving filter performance at every service point.

Write today for complete information. Please address your inquiry to Dept. RM-11.

Sales Agents:

MOUNTAIN REGION SUPPLY CO.
513 City National Bank Building
Omaha, Nebraska—Jackson 0246

O.K. COMPANY
513 Railway Exchange Building
Chicago, Illinois—Harrison 8955

TOM HODGES
216 Norman Road
Greenacres—Portsmouth, Va.

W. O. JENKINS
1317-18 Praetorian Building
Dallas, Texas—C-4850

LACLEDE CHRISTY ARCH COMPANY
Railway Div.—1711 Ambassador Bldg.
Saint Louis, Missouri—Chestnut 6800

FRANK M. SWEENY
5724 Kenmore Road
Baltimore 10, Md.—Tuxedo 024

PAUL D. CURTIS CO.
First National Bank Building

C. A. OTTO
Box 123

JOHN B. McGILLIS
4500 Rosedale Avenue

PAXTON-MITCHELL CO.
OMAHA 5, NEBRASKA

Railway Supplies — Specialty Appliances, Tools and Parts for Locomotives and Cars including: SELF-SEALING QD COUPLINGS • SAFE-N-EZY VALVE SPRING DEPRESSORS • BINGHAM CRANKSHAFT SLEEVING PROCESS • SAFE-N-EZY BELT CUTTERS • P-M METALLIC PACKING • SAFE-N-EZY FILTER WASHER-OILER • PAXMITE IRON CASTINGS.

ORDERS AND INQUIRIES FOR NEW EQUIPMENT PLACED SINCE THE CLOSING OF THE SEPTEMBER ISSUE—(*Continued*)

[5] Purchase contemplated through a conditional sales agreement.
[6] Deliveries expected to begin early next year. The cars will cost about $33,000,000.
[7] To cost $5,200,000.
[8] Purchase arranged through a conditional sales agreement.
[9] Delivery scheduled for the third quarter of 1951.
[10] Estimated cost $2,750,000. To be divided equally between the Gulf Coast Lines and the International-Great Northern.
[11] In addition to the order for 6,001 cars of various types reported in the September issue. The New York Central System also plans to recondition 3,000 gondola cars at an estimated cost of $5,400,000. The estimated cost of the 1,000 box-cars listed above is $5,000,000.
[12] In addition to the 10,000 cars leased from the Equitable Life Assurance Society as reported in the June and September issues.
[13] Deliveries expected to begin in the third quarter of 1951. Of these cars, which will cost more than $10,000,000, are
[14] For delivery in the third quarter of 1951.

NOTES:

Chicago, Burlington & Quincy.—The Burlington has announced plans to acquire 2,200 freight cars costing $13,000,000. The equipment will include 1,000 box cars, 400 flat cars, 200 hopper cars, 250 gondola cars, and 350 refrigerator cars.

Colorado & Southern.—The Colorado & Southern plans to acquire 250 box cars.

Fort Worth & Denver City.—The F.W. & D.C. has been authorized to acquire 250 box cars.

Long Island.—The Long Island has requested Federal Court permission to purchase 12 Diesel-electric locomotive passenger units, including four 2,400-hp. units, six 1,600-hp. units with multiple-unit controls and two 1,600-hp. units not equipped with such controls. Acquisition of these units would permit retirement of 17 steam locomotives and completely Dieselize passenger service in the road's non-electrified territory. The lowest quotation received by the road for this equipment was that of Fairbanks, Morse & Co., amounting to $2,072,888, including freight charges. The new Diesels would be purchased with funds from sale of surplus electrical material, equipment and scrap.

Louisville & Nashville.—The L. & N. has announced plans to purchase an additional 26 Diesel-electric locomotive units. Four will be 2,250-hp. passenger units and 22 will be 1,500-hp. dual-purpose units intended primarily for passenger service. When delivered (sometime after May 1, 1951) the new locomotives are expected to displace some of the road's heavier steam power into freight service, and permit retirement of some 46 older steam passenger units. The new locomotives are expected to cost $4.6 million.

Minneapolis & St. Louis.—The Minneapolis & St. Louis has been authorized to purchase 700 50-ton box cars and 100 flat cars.

Louisville & Nashville.

Earl C. Payne, consulting engineer, Pittsburgh Consolidation Coal Company.

H. G. Pike, superintendent of equipment, Pittsburgh & Lake Erie.

W. O. Cottingham, superintendent of locomotive performance, Western Maryland.

Experimental Locomotive with Cinder-Collection and Ash-Disposal System, by Elmer J. Boer, assistant supervisor; John M. Allen, research engineer, and Bertrand A. Landry, supervisor, Battelle Memorial Institute.

WEDNESDAY, NOVEMBER 29

9:30 a.m.

Gas Turbine Power (V)—Fuels (III)

Pressure and Residence Time Effects on Combustion of Pulverized Coal, by W. E. Young.

Technical and Commercial Aspects of the Application of Residual Oil as Fuel for Gas Turbines and High-Temperature Boilers, by C. F. Kottcamp and L. O. Crockett, Gulf Oil Corporation.

Railroad (III)

Progress in Railway Mechanical Engineering—Report of Committee RR-6, by R. M. Coultas, transportation divisions, General Electric Company.

Progress Report on the Alco-GE Gas-Turbine Electric Locomotive, by A. H. Morey, locomotive engineering division, General Electric Company.

Development of the Aluminum Tank Car, by G. B. Hauser, chief railroad development engineer, Aluminum Corporation of America.

THURSDAY, NOVEMBER 30

12:15 p.m.

Fuels luncheon. Speaker, Dr. James Boyd, director, Bureau of Mines; subject, Change in Patterns of Fuel Supply.

2:30 p.m.

Petroleum (I)

The Properties and Performance of Silicone Lubricants, by G. Grant, 3rd, and C. C. Currie. Dow Corning Corporation.

Some Industrial Experiences with Synthetic Lubricants, by C. H. Sweatt and T. W. Langer, Union Carbide & Carbon Corp.

FRIDAY, DECEMBER 1

2:30 p.m.

Fuels (IX)—Air Pollution—Power (III)

Background of Present Smoke-Regulation Ordinances. by J. P. Burkley, chief fuels utilization Division, U. S. Bureau of Mines.

Present Status of Air-Pollution Control, by H. P. Munger, assistant supervisor in charge of air pollution control, Battelle Memorial Institute.

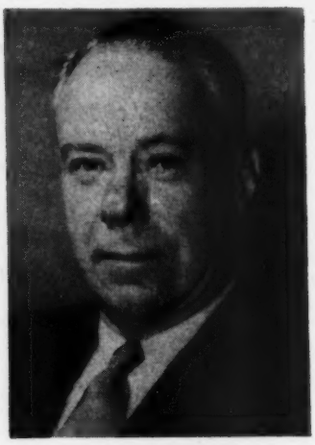
MISCELLANEOUS PUBLICATIONS

MODERN ARC WELDING LESSONS AC & DC. *Published by Hobart Trade School, Inc., Troy, Ohio. 192 pages, with fabricoid cover. Price, $1.* This book comprises the second part of the new five-part Hobart handbook "Electric Arc Welding—Procedure and Practice" and contains the complete series of 40 arc-welding lessons offered at the Hobart Trade School. Chapter headings include: Preliminary Instructions, Starting and Manipulating the Arc, Welding Common Joints With Bare Electrodes, Welding Light Gage Sheets With Coated Electrodes, General Welding With Coated Electrodes in the Flat, Horizontal, Vertical and Overhead Positions, Pipe Welding, Welding Cast Iron, and Special Practices and Tests. The text material is divided into welding exercises of gradually increasing difficulty. The student is taken through the various problems involved in practical arc welding as rapidly as he can master the principles involved. The book is written in easy-to-understand words and contains descriptive pictures, charts and diagrams.

SUPPLY TRADE NOTES

SYMINGTON-GOULD CORPORATION.—*Hynes Sparks* has been elected president of the Symington-Gould Corporation, to succeed *Peter F. Rossmann*, resigned. Mr. Sparks will continue in charge of general sales policies and will make his headquarters in the New York office.

Mr. Sparks joined the firm in its Rochester, N. Y., plant shortly after his discharge from the Army in 1919 and was



Hynes Sparks

transferred to the New York sales office in January, 1920. He was appointed manager, eastern sales, in 1938, and was elected vice-president in March, 1942. During World War II he was principal industrial specialist in the forgings and castings section of the steel division, War Production Board.

◆

HYSTER COMPANY.—The *Ortner Company*, Terrace Plaza building, Cincinnati, Ohio, has been appointed special sales representative to contact a number of eastern railroads in connection with Hyster lift trucks, turret trucks, straddle trucks, attachments and parts.

◆

GENERAL ELECTRIC COMPANY.—*W. C. Harris* has been appointed manager of engineering of the locomotive and car equipment divisions of the General Electric Company's apparatus department to succeed *H. W. Gouldthorpe*, recently appointed manager of the transportation divisions in Schenectady, N. Y. *R. A. Hutchins* has been appointed to the newly created post of assistant to the manager of the locomotive and car equipment divisions.

Mr. Harris joined G. E. in 1911 on its test engineering program soon after graduating from Virginia Polytechnic Institute with a degree in electric engineering. Later he was assigned to the railway en-

MICRO-MAZE*

AN ENTIRELY NEW CONCEPTION OF LUBRICATING OIL FILTRATION EFFICIENCY

At a time of rising costs and lowering quality, WIX presents a new and welcome reversal of these trends. MICRO-MAZE, the result of years of research, brings to diesel filtering greatly increased performance and economy, i.e.:

RATE OF FLOW	**Greatly Increased**
RETENTION OF DIRT & SLUDGE	**Far Greater**
MILEAGE	**Far Greater**
COST OF CLEANING OIL	**FAR LESS**

MICRO-MAZE is an entirely new concept as well as a new formula. While similar in outward appearance to the standard waste cartridge, the MICRO-MAZE construction forms a labyrinth of countless sludge trapping passages which do not collapse or mat down. Thus "surface coating" and "unloading" are largely eliminated . . . the oil is enveloped and filtration accomplished *within* the cartridge rather than at its outer surface. Flow and cleaning efficiency remain high throughout the longer service life of MICRO-MAZE . . . more than is required to keep abreast of dirt "throw down" in a diesel engine in operating condition.

MICRO-MAZE is calculated to reduce overall lubricating oil filtering costs from 30% to 50%. Get the full story from actual experience in *your* filters without delay.

* PATENT PENDING.

WIX Replacement Cartridges of conventional cotton or Micro-Maze construction are available for all lube oil filters. Fuel Oil Replacement Cartridges are available in cotton or filter paper.

wix

TRADE MARK REG.

ENGINEERED FILTRATION

INDUSTRIAL DIVISION

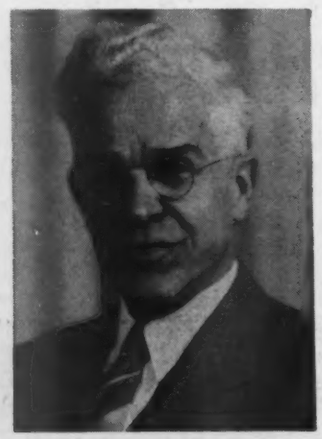
WIX ACCESSORIES CORP'N. • GASTONIA, N. C.

gineering division and in 1917 was commissioned a first lieutenant to serve overseas during World War I. In 1925 he transferred to G.E.'s railway traction division, and two years later was appointed assistant engineer of the automotive engineering

W. C. Harris

division. In 1930 Mr. Harris moved to Erie, Pa., and was named engineer of the automotive engineering division. Five years later he became assistant to the Erie works manager and in 1945, Erie works engineer. He later became designing engineer for the locomotive and car equipment divisions.

Mr. Hutchins, born in Wyoming, Pa., came to G.E. from Pratt Institute in 1909 as a student on the test engineering program. He joined the railway motor engi-



R. A. Hutchins

neering division in 1911 and in 1926 was transferred to Erie. Later he traveled throughout Argentina, Brazil, and Uruguay for the international General Electric Company. In 1932 he was appointed section head in the railway motor engineering division.

◆

ELECTRIC STORAGE BATTERY COMPANY.—*Ross R. Moore*, formerly manager of the Electric Storage Battery Company at Denver, Colo., has been appointed manager of engineering sales, with headquarters in Philadelphia, Pa. Mr. Moore succeeds *W. B. Bowie* who has retired. *Thomas H. Dooling*, Pacific Coast manager, has been appointed western states manager, with his territory expanded to include the Denver, Colo., branch. *James G. Bouska*, service engineer at Los Angeles, Calif., has been appointed manager of the Denver, Colo., branch.

Mr. Moore is a graduate of the University of Southern California, where he

R. R. Moore

received the degree of bachelor of electrical engineering in 1934. He became a sales engineer for the Electric Storage Battery Company in 1935 and continued as such until 1948 except for four years when he served as a lieutenant commander in the Navy during World War II.

◆

FAIRBANKS, MORSE & CO.—*J. G. Graham*, who has for the past several years been with the Railroad Locomotive division of Fairbanks, Morse & Co. at Chicago, has been appointed eastern regional manager of locomotive sales. Mr. Graham will be located at New York, where he will have jurisdiction over sales of locomotives in the New York, Southeastern and Cleveland areas. *D. C. Prescott*, a representative of the locomotive sales staff in the Chicago district, has been appointed district manager—locomotive sales of the Southwestern district, and will be located in St. Louis, Mo., after October 1. *C. H. Morse, Jr.*, assistant manager of Diesel locomotive service, with headquarters at the Beloit (Wis.) Works, has been appointed district manager—locomotive sales, with headquarters at Chicago, and jurisdiction over the Chicago and St. Paul-Minneapolis areas.

◆

DAN S. ELLIS has resigned as president of the Lima-Hamilton Corporation to become executive vice-president of the Gramm Trailer Company.

◆

GENERAL MOTORS CORPORATION.—*Charles E. Wilson*, president of the General Motors Corporation, has received the American Society for Metal's 1950 Medal for the Advancement of Research.

◆

AMERICAN BRAKE SHOE COMPANY.—*Maurice N. Trainer*, formerly first vice-president of the American Brake Shoe Company, has been elected president to succeed *William B. Given, Jr.*, who has become chairman of the board. *Fred P. Biggs* has become president of the *Brake Shoe and Castings division* of the company, and *Stephen S. Conway*, vice-president in charge of sales of the Brake Shoe and Castings and Southern Wheel divisions. *Ralph L. Robinson* has been appointed vice-president of the two divisions and *Edward R. Anderson*, vice-president of the Brake Shoe and Castings division.

Mr. Biggs has served in various sales capacities since joining the company in

(*Bradford Backrack photo*)

F. P. Biggs

1916. He became vice-president in charge of sales of both Brake Shoe and Castings and Southern Wheel Divisions in 1944, and first vice-president of the Brake Shoe Division in 1948.

Mr. Conway was first employed at the division's Chicago office in 1912. He be-

S. S. Conway

came a sales representative in 1929, assistant vice-president in 1944, and vice-president in 1947. Mr. Conway will be located in New York.

◆

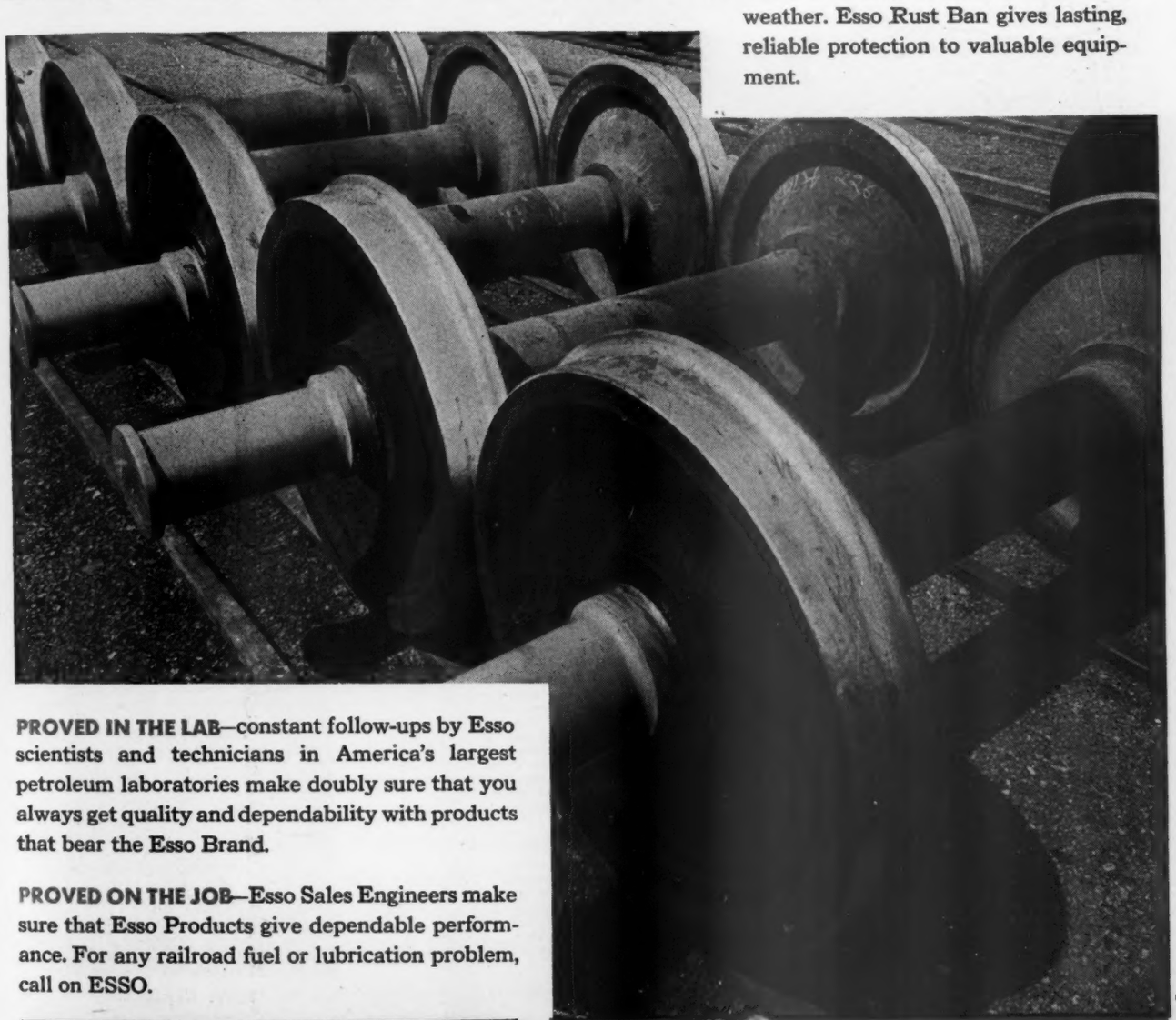
AMERICAN LOCOMOTIVE COMPANY.—*Robert H. White* has retired as chief engineer-manufacturing of American Locomotive Company and *H. V. Gulick* has been appointed his successor.

Mr. White was born in Plattsmouth, Neb. He received the degree of B. S. in Electrical Engineering from the University of Nebraska in 1905, and joined the main-

Month after month

ESSO RUST BAN — provides a highly efficient, protective coating for stored railroad equipment such as anti-friction journal bearings, axle journals, and diesel engine parts.

PROVED IN USE—on parts stored outside for long periods, in all kinds of weather. Esso Rust Ban gives lasting, reliable protection to valuable equipment.



PROVED IN THE LAB—constant follow-ups by Esso scientists and technicians in America's largest petroleum laboratories make doubly sure that you always get quality and dependability with products that bear the Esso Brand.

PROVED ON THE JOB—Esso Sales Engineers make sure that Esso Products give dependable performance. For any railroad fuel or lubrication problem, call on ESSO.

ESSO RUST BAN 343—for stored roller bearings, is easily applied and does *not* require removal when bearings are put in service.

The Sign of QUALITY — Esso — The Symbol of SERVICE

RAILROAD PRODUCTS

SOLD IN: Maine, N. H., Vt., Mass., R. I., Conn., N. Y., N. J., Penna., Del., Md., D. C., Va., W. Va., N. C., S. C., Tenn., Ark., La.

ESSO STANDARD OIL COMPANY—Boston, Mass.—New York, N. Y.—Elizabeth, N. J.—Philadelphia, Pa.—Baltimore, Md.—Richmond, Va.—Charleston, W. Va.—Charlotte, N. C.—Columbia, S. C.—Memphis, Tenn.—Little Rock, Ark.—New Orleans, La.

a

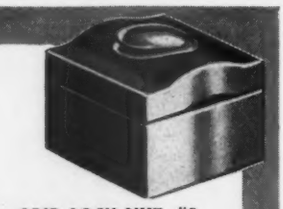
GRIP NUT

applied

is a

GRIP NUT

locked!



GRIP LOCK NUT #1
Applied on top of nut already in place on old equipment or on new applications to prevent the common nut from loosening

GRIP HOLDING NUT #2
(FREE SPINNING or LOCKING)
An inexpensive single locking nut to be used where the load is light, such as on siding, decking, pipe clamps, etc. For speedy application, specify Free Spinning type—spins on, locks by final pressure against work.

GRIP UNIT NUT #3
A heavy duty single nut that can be used anywhere — everywhere The economical nut for use on new bolts since it eliminates the use of a second nut or a spring washer

GRIP LOCO NUT #4
A special hot forged heavy duty nut, used with a half nut to hold moving parts in adjustment. The inner half nut makes adjustment easy When adjustment is complete the Grip Locomotive Nut holds it against movement.

SPECIAL FRONT END NUT
Of an uncommon design that provides a face more than twice the surface of a standard size nut of like dimension. Made to adequately cover the miscellaneous varieties of holes in the front end of a smoke box

Grip Nut Products are made only by the Grip Nut Company, the oldest lock nut company — *serving the railroads since 1906.*

GRIP NUT

NUT COMPANY

310 SOUTH MICHIGAN AVENUE

CHICAGO 4, ILLINOIS

tenance department of Alco at Schenectady in 1906 after a year with the General Electric Company as a test engineer. Since 1918 he has been in charge of all company construction engineering. During both World Wars he supervised development of production facilities at all Alco plants and at Montreal Locomotive Works, Alco's Canadian affiliate. Mr. White also directed building, power and shop-equipment projects involved in Alco's postwar expansion program at plants in Schenectady, Auburn, N. Y., Dunkirk, Latrobe, Pa., and Chicago Heights, Ill. Mr. White is a member of the American Society of Mechanical Engineers.

Mr. Gulick was born in Brooklyn, N. Y. He is a graduate of Union College with a B.S. degree in Civil Engineering (1919). He served as a bridge designer with the Illinois State Highway Department and the Chicago, Milwaukee and St. Paul Railway from 1919 until 1923, and from 1923 until 1926 was employed in Alco's engineering construction department. Until 1931 he was associated with Gannett, Seelye & Fleming, consulting engineers, at Harrisburg, Pa. In 1931 he returned to American Locomotive and since then has been project engineer and later assistant chief engineer.

◆

PRESSED STEEL CAR COMPANY.—*Richard T. Coyne* has been appointed vice-president, laminate structure sales, of Pressed Steel Car Company, Chicago.

Mr. Coyne was previously sales agent for the Pullman-Standard Car Manufacturing Company. He was sales manager of the Mt. Vernon Car Manufacturing Company from 1944 through 1946. He is a member of the New York Railway Club and the Western Railway Club.

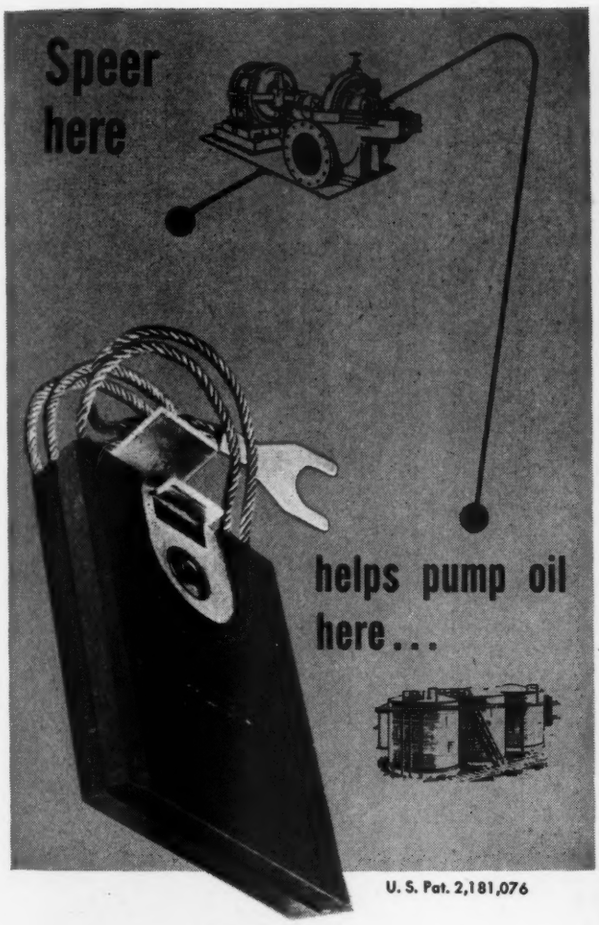
R. T. Coyne

◆

MAGNAFLUX CORPORATION.—New Dallas, Tex., headquarters for the Magnaflux Corporation have been opened at 2823 Manor way, replacing former headquarters destroyed by an aircraft crash last November.

◆

KERITE COMPANY.—*M. C. Blevins* has been appointed assistant western manager of the Kerite Company, with headquarters at Chicago. *Ernst Ohnell, Jr.*, has been made manager of power and industrial sales covered by the New York office of



SPEER carbon brushes, with their freedom from sparking, overheating, and energy loss, are widely used in the electric motors that gather and pump oil. The high current-carrying capacities and excellent contact provided by Speer brushes make them equally valuable in motors for *any* pumping job.

A complete line of brushes has been developed by Speer to match every mechanical and electrical service characteristic. All have been rigidly tested under actual service conditions. For smooth, trouble-free commutation ... for peak motor performance ... fit your motors with Speer carbon brushes.

Speer

CARBON COMPANY
ST. MARYS, PENNA.

brushes • contacts • welding electrodes • graphite anodes • rheostat discs • packing rings • carbon parts

CHICAGO • CLEVELAND • DETROIT
MILWAUKEE • NEW YORK • PITTSBURGH

EX-CELL-O

RAILROAD PINS and BUSHINGS WEAR LONGER

Diesel equipment brings new maintenance problems to America's railroads. Ex-Cell-O's methods of manufacturing railroad pins and bushings assure uniformity in size and quality that is essential to long service. The correct heat treatment gives an extremely hard surface for wear resistance and a tough ductile core to withstand shocks and vibration. Precision grinding assures a uniformly good finish and accurate size.

XLO
EX-CELL-O for PRECISION

Whether your problems concern new work or maintenance on steam or Diesel equipment, it will be to your advantage to use Ex-Cell-O hardened and ground steel pins and bushings. Write today for a new catalog of standard types and sizes—ask for Bulletin No. 32381.

Railroad Division
EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

As specialists for over 40 years in brushes for all types of electrical rotating equipment, Stackpole has played a big part in developing better carbon brush grades for modern Diesel motors, generators and auxiliary equipment. Each Stackpole brush recommendation is based on actual "on the job" tests that assure top notch performance, minimum commutator maintenance and maximum brush life for your specific operating conditions.

Stackpole Diesel Brushes are sold only to makers of original Diesel equipment. Replacement brushes can be purchased through these manufacturers.

STACKPOLE CARBON CO.
ST. MARYS, PA.

RAIL BONDING MOLDS • CARBON RHEOSTAT DISCS • PUMP AND FLUID DRIVE SEALS • WELDING CARBONS • BRAZING TIPS • ELECTRONIC COMPONENTS • CONTACTS and dozens of other items.

Kerite. He will continue as export manager, and *Lee W. Eighmy, Jr.*, has been appointed his assistant.

Mr. Blevins was born in St. Joseph, Mo. He attended the University of Chicago, and after his schooling, was first associated with the Indiana Harbor Belt mechanical department in the Chicago area. He later joined the mechanical department of the Boston & Maine at Concord, N. H., and subsequently went with Lever Brothers Company, in its sales department. In 1940, he entered the service of Kerite in its New York office sales department, being transferred to Chicago later the same year.

◆

SUPERIOR STEEL & MALLEABLE CASTINGS CO.—*Lloyd E. Young* has been appointed

L. E. Young

sales manager of the Superior Steel & Malleable Castings Co.

◆

CUMMINS ENGINE COMPANY.—*Burton C. Sears*, formerly sales engineer for the Cummins Engine Company, Columbus, Ind., has been appointed assistant regional manager for the southeastern region, with headquarters at 800 Ponce deLeon avenue, N.E., Atlanta, Ga. *Edward Daley*, formerly San Francisco, Cal., district manager for the Marion Power & Shovel Co., has been appointed assistant regional manager for Cummins, with headquarters at 411 West Fifth street, Los Angeles, Calif.

◆

D. J. MURRAY MANUFACTURING COMPANY.—The Chicago office of the D. J. Murray Manufacturing Company is now at 612 North Michigan avenue in the Michigan-Ohio building. *O. J. Malina*, sales manager of the Unit Heater division, is in charge.

◆

NATIONAL TUBE COMPANY.—*George O. Nations* has been appointed assistant to general manager of sales of the National Tube Company, a subsidiary of the United States Steel Corporation.

Mr. Nations joined the sales office of National Tube in 1939 at Denver, Colo. He held various positions in the sales and operating departments and was appointed manager of claims in November, 1948.

◆

MONTREAL LOCOMOTIVE WORKS.—*D. W. Cameron*, formerly general superintendent of the Schenectady, N. Y., plant of the *American Locomotive Company*, has been

Black & Decker Tool Users . . .

FACTORY SERVICE Always NEARBY for You!

CHICAGO BRANCH

ATLANTA BRANCH

29 B&D BRANCHES WITHIN 24 HOURS OF ANY CUSTOMER

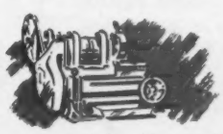
Atlanta, Ga.	Los Angeles, Calif.
Baltimore, Md.	Memphis, Tenn.
Boston, Mass.	Minneapolis, Minn.
Buffalo, N. Y.	Montreal, Que., Canada
Charlotte, N. C.	Newark, N. J.
Chicago, Ill.	New Orleans, La.
Cincinnati, Ohio	New York, N. Y.
Cleveland, Ohio	Philadelphia, Pa.
Dallas, Texas	Pittsburgh, Pa.
Denver, Colo.	Portland, Ore.
Detroit, Mich.	St. Louis, Mo.
Houston, Texas	San Francisco, Calif.
Indianapolis, Ind.	Seattle, Wash.
Kansas City, Mo.	Toronto, Ont., Canada
Winnipeg, Man., Canada	

Yo get maximum productive life out of every Black & Decker Tool you own when you take advantage of our genuine, guaranteed "Factory Service" at reasonable cost! These Factory Service Branches are *owned and operated by Black & Decker,* not merely local repair shops "licensed" by a manufacturer. They carry genuine B&D parts in stock, use no substitutes or makeshifts. And you deal *directly* with Black & Decker, enjoy all the advantages of B&D's famous service policy and guarantee.

There are 29 B&D Branches spread across the map. We're constantly expanding their number and increasing their facilities to bring *better* service *closer* to *more* customers. If and when you need repairs on a B&D Tool, use the Service Branch nearest you. It saves you time, trouble and money! THE BLACK & DECKER MFG. CO., 665 Pennsylvania Ave., Towson 4, Md.

. . . And Each Service Branch is

. . . manned by expert mechanics trained in our own factory at Towson, Maryland.



. . . equipped with special electric tool servicing equipment for finer repair work.

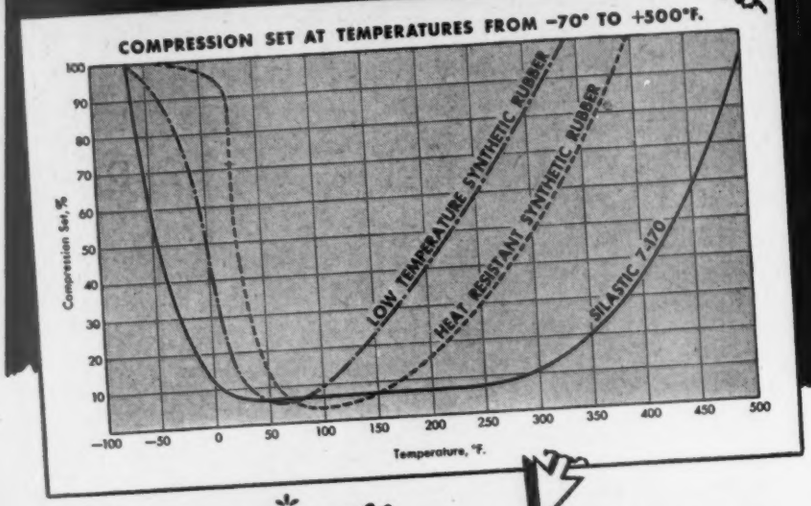
. . . stocked with genuine Black & Decker replacement parts for trouble-free running.

LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker

PORTABLE ELECTRIC TOOLS

Where ordinary rubber gaskets fail . . .



SILASTIC* still stays Elastic!

AT EXTREME TEMPERATURES, Silastic has greater resistance to compression set—or to permanent deformation due to heat and pressure—than any other rubberlike material. Its elastic memory exceeds that of both the best low temperature and the best high temperature organic rubbers available. Silastic 7-170 forms a more resilient seal at −50°F. than a special low temperature organic rubber does at −7°F. At 450°F., Silastic has more resistance to permanent compression set than the most heat-stable organic rubbers have at 330°F.

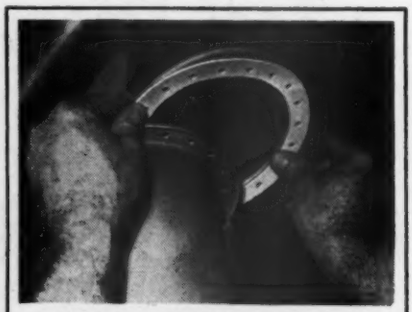
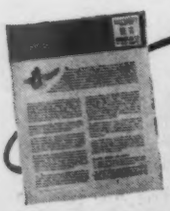


PHOTO COURTESY CONSOLIDATED VULTEE AIRCRAFT CORP.

In aircraft cabin heating and pressurizing systems, Silastic gaskets stay elastic under operating temperatures ranging from −70° to 400°F. Similarly, Silastic gaskets and O-rings withstand hot oils at about 450°F. in automotive, aircraft, diesel-electric engines.

Combine that kind of elastic memory with excellent resistance to aging, to oxidation and to attack by a variety of chemicals and hot oils, and you have Silastic—the most stable of all resilient gasketing materials. That's why design engineers and maintenance men specify Silastic, the Dow Corning Silicone rubber that pays for itself many times over in reduced maintenance costs and improved performance.



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appointed manager of operations of the *Montreal Locomotive Works, Ltd. Charles P. Madely*, formerly plant manager, has been appointed manager of industrial sales, a newly created position.

◆

FLANNERY MANUFACTURING COMPANY.—The name of the *Flannery Bolt Company* has been changed to the Flannery Manufacturing Company.

◆

GRIP NUT COMPANY.—*John H. McCartney* has been appointed regional sales engineer, eastern territory, for the Grip Nut Company. Mr. McCartney will handle matters of sales and service work from Chicago.

◆

REED ROLLER BIT COMPANY.—The Cleco division of the Reed Roller Bit Company has appointed the *Ensminger Company*, Wilkes-Barre, Pa., as distributors of Cleco products in that area.

◆

ELECTRIC SERVICE MANUFACTURING COMPANY.—The *E. A. Lundy Company* has been appointed exclusive agent for sale to the New York Central System of the Electric Service Manufacturing Company's entire line of transportation equipment.

◆

CLIMAX MOLYBDENUM COMPANY.—*Walter F. Craig, Jr.*, has become metallurgical engineer in the Chicago office of the Climax Molybdenum Company. Mr. Craig was previously supervisor, ferrous metals research, at the Armour Research Foundation.

◆

D. J. MURRAY MANUFACTURING COMPANY.—*C. H. Broward* has been appointed representative for grid unit heaters. Mr. Broward's territory includes Georgia, North Carolina and South Carolina, and Polk, McMinn, Roane, Morgan and Scott counties in Tennessee.

Obituary

LEO P. DUGGAN, district sales manager of the Garlock Packing Company at Philadelphia, Pa., died on September 21 after a short illness. Before Mr. Duggan joined Garlock in 1909 as a railroad sales representative, he had been a storekeeper with the Chesapeake & Ohio.

PERSONAL MENTION

General

R. B. DULANEY, staff assistant of the Atlantic Coast Line, has been appointed assistant to general superintendent motive power and equipment, with headquarters as before at Wilmington, N. C.

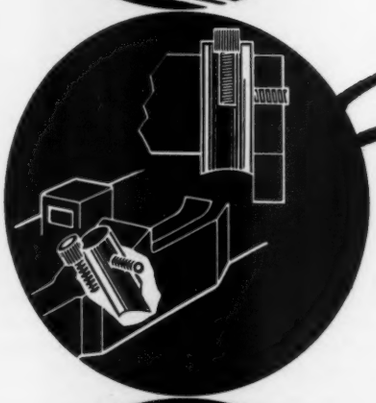
H. H. LANNING, mechanical and research engineer of the Atchison, Topeka & Santa Fe at Topeka, Kan., has retired.

WALLACE H. CHAPLIN, assistant general Diesel foreman of the Boston & Maine, has been appointed assistant to superintendent of locomotive maintenance of the

Cut Down High Flanges Without Laying-Up Equipment

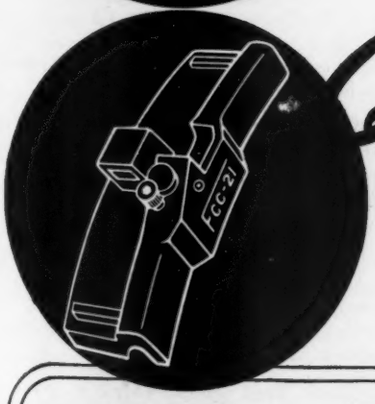
Simply

To take down a high flange, you simply remove the regular brake shoe and replace it with an FCC-21 Combination Cutter Shoe. This installation does not require disassembly of the brake rigging, and is made in a matter of minutes.



Accurately

The cutting itself is accomplished with a carbide cutter, formed to the correct flange contour. The FCC-21 Cutter once adjusted—and this is quickly and easily done —remains as fixed in its relation to the wheel as it would in a lathe. The cutter's stable angle results in a uniform smooth cut.



Quickly

As the Diesel moves down the track, the rate of feed of the carbide tool is in exact ratio to the turning of the wheels being cut. The chip emerges in a continuous ribbon of uniform thickness. In 20 minutes—or less—your flange is reduced to proper limits and your equipment is ready for service again.

YOU ARE INVITED TO SEE A DEMONSTRATION

This revolutionary new Cutter FCC-21 has been approved without qualification by Superintendents and Master Mechanics who, having seen it, are using it. Our field representative will gladly give you a personal demonstration or take you to see one. Write for information and descriptive bulletins.

Serving the Railroad Industry for Fifty Years

WHEEL TRUING BRAKE SHOE CO.

628 West Baltimore Ave., Detroit 2, Michigan

Cleaning the Outside of the Inside of Diesel Locomotives!

There's plenty of oil and road dirt to remove from surfaces of diesel locomotive engines. When you make it a hand job, using cleaners that call for elbow-grease, the cost per locomotive runs high in time and labor. You can do this job at a cost of less than $2 per engine with

SUPER-MAGNUSOL

One man is required. He sprays a mixture of one part Super-Magnusol to six parts safety solvent (at room temperature) on surfaces to be cleaned, starting at the top engine surfaces at one end, and working down and along to the other end.

By the time the operator has covered all surfaces, the Super-Magnusol at the end where he started spraying has penetrated to the paint or metal surfaces, loosening all the dirt and oil. The final cleaning is accomplished by flushing with plain water at tap temperature, following the same routine as for the original spraying.

You get spotlessly clean surfaces, including the floor area, which is rinsed off last. There's no attack on paint or metal. There's no fire hazard. And you'll save from $10 to $12 per engine, all costs included, over hand cleaning with any cleaner you can use.

Seeing is believing. We'll gladly have a Magnus representative show you what a job this Super-Magnusol method does. No obligation, of course.

Railroad Division

MAGNUS CHEMICAL COMPANY • 77 South Ave., Garwood, N. J.

In Canada—Magnus Chemicals, Ltd., Montreal

Magnus CLEANERS AND CLEANING EQUIPMENT

Representatives in all principal cities

Boston & Maine, Maine Central, and Portland Terminal, with headquarters at Boston, Mass.

M. E. FITZGERALD, assistant to superintendent of motive power of the Chicago & Eastern Illinois, with headquarters at the Oak Lawn (Ill.) shops, retired on October 1, after 37 years of service with the road.

J. M. NICHOLSON, director of research of the Atchison, Topeka & Santa Fe at Chicago, has been appointed mechanical and research engineer at Topeka, Kan.

F. B. RYKOSKEY, system supervisor of shops of the Baltimore & Ohio at Baltimore, Md., has been appointed to superintendent of motive power of the Central

F. B. Rykoskey

region at Pittsburgh, Pa. Mr. Rykoskey joined the B. & O. in 1920 as apprentice machinist. He became supervisor of shops for the system at Baltimore in 1944.

J. D. CAVEY, regional Diesel supervisor of the Baltimore & Ohio at Baltimore, Md., has been appointed regional motive power inspector.

J. J. ELKIN, JR., supervisor of lubrication of the Baltimore & Ohio at Baltimore, Md., has been appointed supervisor of shops, with headquarters at Baltimore.

GUY F. MILES, supervisor of Diesel-electric locomotive operation for the Baltimore & Ohio system at Baltimore, Md., has been appointed assistant to the general superintendent of motive power and equipment, with headquarters at Baltimore.

HARRY REES, superintendent of motive power of the Central region of the Baltimore & Ohio at Pittsburgh, Pa., has been granted leave of absence because of ill health.

L. E. ABBEY, division master mechanic of the Canadian Pacific at Kenora, Ont., has been appointed assistant superintendent-division master mechanic, with headquarters at Penticton, B. C.

L. E. HART, personnel officer of the Atlantic Coast Line at Wilmington, Del., has been appointed assistant general superintendent motive power and equipment, with headquarters at Wilmington.

FRANK WILLIAMS, chief mechanical engineer of the Canadian National at Mont-

MAINTENANCE OPERATOR (above) removes clean filter screens. (Note their shiny appearance.) Soiled screens in tank and at right.

SOAK TANK CLEANING (right) of Diesel heads and liners. Pennsalt No. 35® and good rolling boil get parts clean as new.

Here's why the Burlington Route uses Pennsalt Cleaners for Diesel maintenance

It's a tough job to get dirt, grease and carbon out of places like piston ring grooves and filter screen perforations!

That's why Diesel maintenance men insist on cleaners that are fast and thorough. That's why railroads like the Burlington choose Pennsalt Cleaners for the task . . .

The Burlington has been using Pennsalt Cleaner No. 35 for more than 10 years. There must be good reasons . . . here they are:

1. Longer Lasting! Pennsalt Cleaner solutions not only do a better cleaning job—they also last a longer time. Effective strength at low concentrations is a standard characteristic.

2. More for your Money! You don't buy a lot of water in Pennsalt Cleaners—because they're essentially anhydrous. That means virtually 100% active ingredients in every drum.

3. Higher Quality at Lower Cost! You get guaranteed high quality at low cost when you buy from Pennsalt. No "middle man" charges! As a *basic* producer, Pennsalt controls the manufacture of its products from raw material to finished form.

REMEMBER! Pennsalt backs up all of its cleaners with technical service right in your shop. Our representative is trained to analyze every type of cleaning problem. Why not let him study *your* present methods, and possibly show you savings in maintenance costs?

Write today for further information to: Special Chemicals Department, Pennsylvania Salt Manufacturing Company, Philadelphia 7, Pa.

TWO CENTURY-OLD COMPANIES: Like Pennsalt, the Burlington recently completed 100 years of service to the nation! The Burlington was the pioneer of Diesel streamlined trains and Vista-Dome Cars.

PENN SALT *railroad maintenance cleaners*

Progressive Chemistry for a Century

with **IRVINGTON**
class H Insulations

Your motive power's electrical equipment runs 500° F. *cool* when protected with Irvington Class H flexible insulations. For these remarkable high-temperature materials make railway motors and generators more dependable than ever.

The greater heat resistance of Class H insulations permits higher ambient temperatures, increases safety factor, and materially prolongs insulation life. If your diesel-electrics seem to suffer from too many motor and generator burn-outs, rebuild with Irvington Class H insulations . . . to sustain heavier overloads, to cut repair costs, to boost availability.

Select Class H Insulations from this Extensive Irvington Line: Silicone Varnished Fiberglas*—Silicone Varnished Fiberglas* Tubing—Silicone Glass Mica—Silicone Coated Asbestos—Silicone Rubber Coated Fiberglas*—Silastic Coated Fiberglas*. Send today for technical data and samples.**

Look to Irvington
for Insulation Leadership

*®Owens-Corning Fiberglas Corp.
**®Dow Corning

IRVINGTON Varnish & Insulator Company
Irvington 11, New Jersey

real, Que., has retired. Mr. Williams was born in England, where he began his railway career with the London & South Western. He went to Canada in 1911 to join the Montreal Locomotive Works. In 1918 he began service with the Canadian Government railways (now part of the C. N. system) as a draftsman in the mechanical department at Moncton, N. B. He became mechanical designer there in 1920; mechanical engineer at Moncton in 1923, and mechanical engineer, shop methods, at Montreal in 1929. In 1933 he was placed in charge of shop methods for the entire system, and in 1943 was appointed chief mechanical engineer.

G. R. THOMAS, assistant superintendent-division master mechanic of the Canadian Pacific at Penticton, B. C., has retired after 41 years' service.

O. L. HOPE, master mechanic, Central Kansas-Colorado divisions, of the Missouri Pacific, at Osawatomie, Kan., has been appointed mechanical superintendent, Southern district, with headquarters at St. Louis, Mo.

Car Department

WILLIAM M. ALMON has been appointed gang foreman car repairs of the Southern at Charlotte, N. C.

ROBERT C. SMITH, JR., has been appointed foreman car repairs of the Southern at Hayne, S. C.

WILLIAM E. HATCHELL has been appointed gang foreman freight-car repairs of the Southern at Columbia, S. C.

ARTHUR EASTHAM has been appointed car foreman of the Southern at Danville, Ky.

CHARLES H. CAWOOD has been appointed foreman coach shop of the Southern at Chattanooga, Tenn.

F. A. HITE, car foreman at the Clare shop of the Norfolk & Western, has been appointed assistant car foreman, car department, at the Portsmouth, Va., shop.

Diesel

HUGH W. STILLINGS has been appointed assistant general Diesel foreman at the Boston, Mass., Diesel terminal of the Boston & Maine.

O. M. DORSEY, Diesel foreman of the Baltimore & Ohio at Cone Yard, East St. Louis, Ill., has been promoted to regional Diesel supervisor, with headquarters at Cincinnati, Ohio.

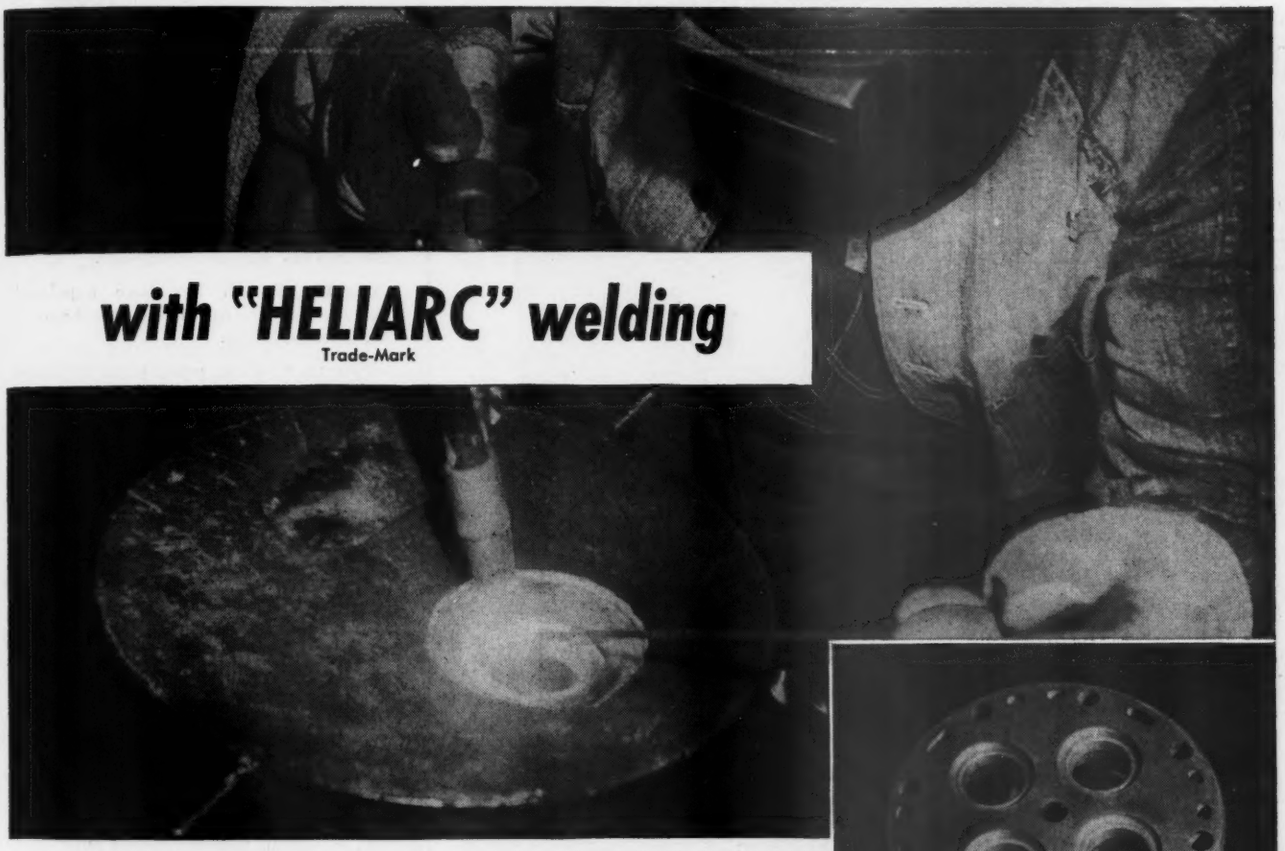
W. C. BROWN, Diesel foreman at the Riverside shops of the Baltimore & Ohio, Baltimore, Md., has been appointed regional Diesel supervisor.

Electrical

WILLIAM B. DOBBS has been appointed foreman electricians of the Southern at New Orleans, La.

FRANK E. STARKWEATHER, electrical engineer of the Chesapeake & Ohio at Grand Rapids, Mich., has retired. Mr. Starkweather was born on August 5, 1885, in Saginaw, Mich. After graduation from high school in 1903, he became employed in

Save $$$ on Cylinder Head Repairs



with "HELIARC" welding
Trade-Mark

Building up a worn valve seat using cast iron rod. Note the compact heat-retaining box.

Cast iron diesel cylinder head repaired by HELIARC welding and ready for thousands of hours more service.

You don't need to scrap worn or cracked cast iron diesel cylinder heads. A worn one can be made as-good-as-new and at less than half the cost of a new head by means of HELIARC inert-gas shielded arc welding. Only with HELIARC welding will the molten cast iron in the puddle take on a remarkable fluidity that makes welding easy.

Cracks near the injector hole and in the areas of the stud holes as well as worn valve seats are speedily repaired using this process.

Ask OXWELD for details on how this and other money-saving repairs are made on diesel parts.

The term "Heliarc" is a registered trade-mark.

OXWELD RAILROAD SERVICE

THE OXWELD RAILROAD SERVICE COMPANY

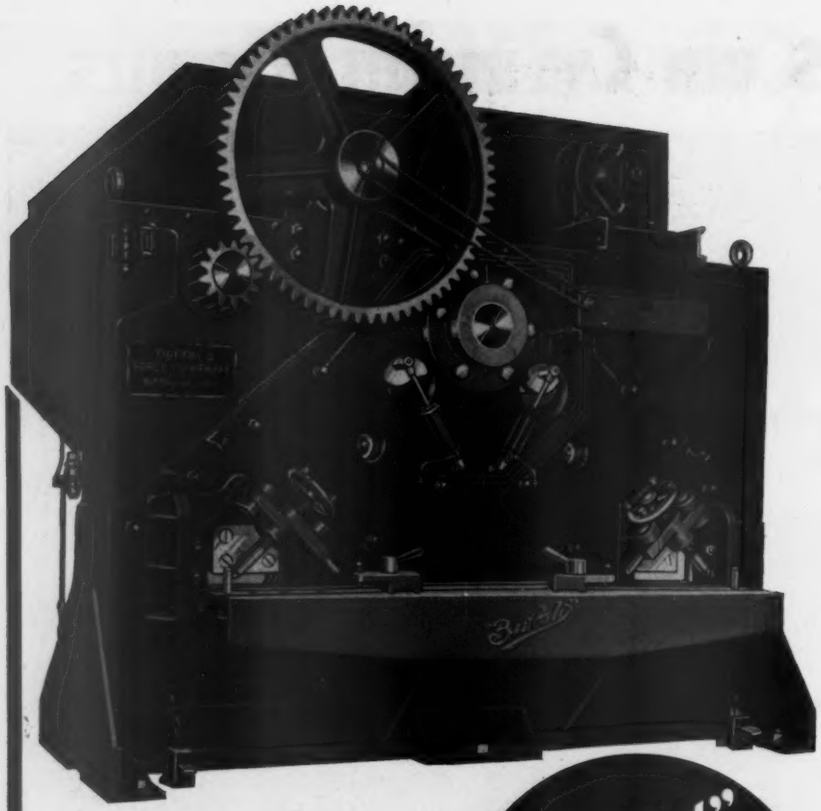
Unit of Union Carbide and Carbon Corporation

UCC

Carbide and Carbon Building — Chicago and New York

In Canada: Canadian Railroad Service Company, Limited, Toronto

SINCE 1912 — THE COMPLETE OXY-ACETYLENE SERVICE FOR AMERICAN RAILROADS



SHEAR ANGLES,
SQUARE OR MITER

SHEAR ROUNDS,
SQUARES, BEAMS, CHANNELS

"Buffalo"
DOUBLE END ANGLES
AND BAR SHEARS

It's "SHEAR COSTS ECONOMY"!

Yes, this one machine can handle a pile of fabrication in your shop! Handles angles, rounds, flats, squares, beams and channels with suitable knives. Electrically welded frames of tremendous strength and rigidity. A machine to take years and years of punishing 24-hour work shifts in your shop—and pay for itself in a hurry. Five standard sizes, with capacity up to 8 x 1⅛" angles, 4⅜" rounds, 4" squares, 6 x 2½" flats. WRITE FOR BULLETIN 310-C.

Replace Obsolete Tools With
MULTI-PURPOSE "BUFFALO" MACHINES!

Let these shears and other "Buffalo" Combination Machines take the place of *many* machines on your floor! You'll get maximum turnout per square foot of floor space, and per dollar invested in machines.

"Buffalo" MACHINE TOOLS
BUFFALO FORGE COMPANY
174 Mortimer St. Buffalo, New York
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

DRILLING PUNCHING CUTTING SHEARING BENDING

the engineering department of the Bartlett Illuminating & Power Co. The following year he joined the General Railway Signal Company's construction department. In 1905 he became chief electrician for the Pere Marquette Coal Company. From 1906 to 1907 he served in the power and switchboard department of the Michigan State Telephone Company, and subsequently joined the Pere Marquette (now P. M. district, C. & O.) as electrician in the signal department. In 1908 Mr. Starkweather became interlocking maintainer, in 1911 electrical foreman; chief electrician in 1913; in 1916 assistant signal engineer, and in 1923 electrical engineer.

HOWARD BROWN has been appointed foreman electricians of the Southern at Chattanooga, Tenn.

WILLIAM C. COX, power-plant engineer, Pere Marquette District, of the Chesapeake & Ohio, has been appointed electrical engineer, with headquarters as before at Grand Rapids, Mich. The position of power-plant engineer has been abolished.

Master Mechanics And Road Foremen

J. J. RABY, division master mechanic of the Canadian Pacific at Saskatoon, Sask., has been transferred to the position of division master mechanic at Kenora, Ont.

W. F. DUNCAN, general foreman, locomotive shop of the Missouri Pacific at Sedalia, Mo., has been appointed master mechanic Central Kansas-Colorado divisions, with headquarters at Osawatomie, Kan.

W. F. DADD, regional Diesel supervisor for the Western region of the Baltimore & Ohio at Cincinnati, Ohio, has been appointed master mechanic, with headquarters at Punxsutawney, Pa.

WILLIAM H. PRINDALL, for the past 25 years master mechanic of the Boston & Maine at Concord, N. H., retired after 51 years of service with the B. & M.

C. W. DAVIS, master mechanic of the Buena Vista shops of the Florida East Coast at Miami, Fla., has retired at his own request after 25 years of service.

A. M. LEWIS, superintendent of shops of the Baltimore & Ohio at DuBois, Pa., has been appointed master mechanic at Willard, Ohio.

EARL C. CONE, assistant to superintendent locomotive maintenance of the Boston & Maine at Boston, Mass., has been appointed master mechanic of the New Hampshire division at Concord, N. H.

E. H. SCHOEDINGER has been appointed master mechanic of the Buena Vista shops of the Florida East Coast at Miami, Fla.

OLIVER COCHRAN, general air-brake inspector of the Canadian Pacific at Winnipeg, Man., has been appointed division master mechanic, with headquarters at Saskatoon, Sask.

Shop and Enginehouse

L. L. ROBINSON, JR., regional motive power inspector of the Baltimore & Ohio

6 POINTS TO REMEMBER WHEN CHOOSING

RAILROAD PASSENGER CAR BATTERIES

EXTRA LONG LIFE. EDISON batteries outlast all others in railroad service. When they finally complete their service life in heavy-duty air conditioning, regroup the cells and get a *second life* in lighter-duty service.

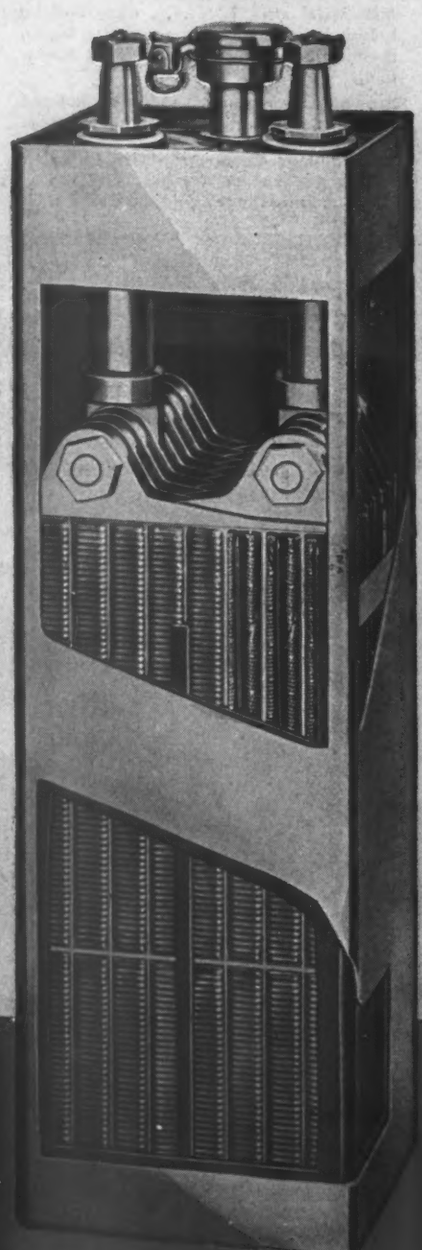
DEPENDABILITY. The name EDISON has been synonymous with dependability for over half a century. EDISON cells provide the closest approach to failure-free standby power known. They won't quit unexpectedly and are easily maintained.

INCREASED DEMANDS. Today's passenger car electrical systems carry unprecedented loads and so require bigger batteries. EDISON, the *original lightweight battery*, has higher capacity per pound . . . keeps total weight down.

STEEL CONSTRUCTION. All EDISON cell containers, pole pieces, grids—even the tubes and pockets containing active materials—are made of rugged steel. The alkaline electrolyte is a recognized preservative of steel.

OVERALL ECONOMY. Select EDISON batteries for long-range economy because they stay on the job, out of the repair shop. They are not subject to injury by freezing, accidental short-circuiting or reverse charging.

NICKEL-IRON-ALKALINE PRINCIPLE. This original EDISON principle is chemically foolproof, electrically trouble-free. For these reasons it is the basis for long life, dependability and overall economy in EDISON batteries.



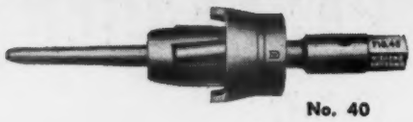
Cutaway view of A8H Edison cell at right illustrates its all-steel construction, including the tubular positive plates.

EDISON
Nickel • Iron • Alkaline
STORAGE BATTERIES

EDISON STORAGE BATTERY DIVISION OF THOMAS A. EDISON, INCORPORATED, WEST ORANGE, N. J.

Wiedeke

TUBE EXPANDERS NATIONALLY KNOWN FOR DEPENDABLE . . . ECONOMICAL Service



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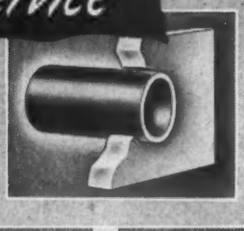
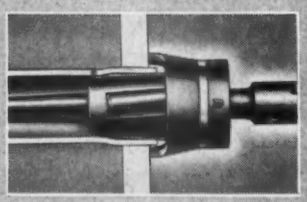
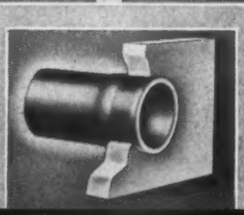






IDEAL ACE TUBE EXPANDERS

The boilermakers' selection for more than a half century, for LOCOMOTIVE and general boiler work . . . guard straddles tube and bears against tube sheet, suitable for rolling new tubes and re-rolling tubes with flared or beaded ends.

MINIMUM FRICTION . . . absorbed by bronze bearing between guard and frame, resulting in much easier and faster operation.

Long rolls have generous radius on end and will not create sharp offset within the tube.

See your dealer or write today for general catalog on Wiedeke Tube Expanders and Tube Cutters.

The Gustav Wiedeke Company

DAYTON 1, OHIO

GOOD RIDING BEGINS WITH GOOD SPRINGS

AMERICAN-FORT PITT SPRINGS

AMERICAN-FORT PITT

Spring Division

H. K. PORTER COMPANY, Inc.

McKees Rocks, Pennsylvania

at Baltimore, Md., has been appointed general supervisor of locomotive maintenance.

WILLIAM R. LONG has been appointed foreman enginehouse (day) of the Southern at Selma, Ala.

WALTER O. THARP has been appointed day enginehouse foreman of the Southern at Chattanooga, Tenn.

W. VAUGHN STEVENS has been appointed night assistant enginehouse foreman of the Southern at Chattanooga, Tenn.

L. R. HAASE, master mechanic of the Baltimore & Ohio at Punxsutawney, Pa., has been appointed superintendent of shops at DuBois, Pa.

L. W. MCALPINE, shop superintendent car department of the Seaboard Air Line at Jacksonville, Fla., has been transferred to the position of shop superintendent at Portsmouth, Va.

CLARENCE L. MCFARLAND has been appointed night enginehouse foreman of the Southern at Selma, Ala.

FREDERICK P. JONES has been appointed night enginehouse foreman of the Southern at Oakdale, Tenn.

Obituary

C. R. RUSH, mechanical superintendent, Southern district, of the Missouri Pacific, at St. Louis, Mo., died recently.

A. A. RAYMOND, superintendent fuel and locomotive performance, New York Central System, whose death was reported in the October issue, was born on November 19, 1886, at Troy, N. Y. He received his mechanical engineering degree at Cornell University in 1910, in June of which year he became a special apprentice in the Avis, Pa., shop of the N.Y.C. In December, 1911, he became shop draftsman; in November, 1912, assistant terminal foreman, engine-

A. A. Raymond

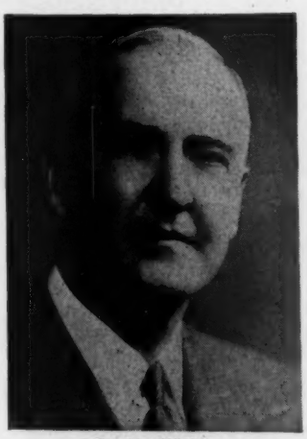
house at Avis; in May, 1916, service test engineer at New York; in July, 1920, assistant master mechanic of the Mohawk division; in November, 1922, assistant master mechanic of the Syracuse division, and in June, 1924, master mechanic of the St. Lawrence division of the N.Y.C. In February, 1926, he was appointed superintendent fuel and locomotive performance, with headquarters at Buffalo, N. Y. Mr. Raymond was a past president of the Interna-

tional Railway Fuel Association, now the Railway Fuel and Traveling Engineers' Association; of the Committee on Utilization of Motive Power of which he was chairman from 1923. From 1930 until 1938 he was chairman of the A.A.R. Working Stoker Committee. He was a member of the American Society of Mechanical Engineers; the Central Railway Club of Buffalo, of which he was a past president; the Western Railway Club, and the New York Railroad Club. He was the author of many papers for railway clubs and technical associations.

JOHN PURCELL, retired mechanical assistant to the vice-president of the Atchison, Topeka & Santa Fe and past chairman of the Mechanical Division of the Association of American Railroads, died at Los Angeles, Calif., on September 29.

ALLAN O. GEERTZ, fuel engineer of the Pennsylvania and a nationally known combustion engineer and authority on coal mining practices, died on September 21 at University Hospital, Philadelphia, Pa., after a long illness. He was 50 years of age.

R. G. WEBB, superintendent air brakes of the Chicago, Milwaukee, St. Paul & Pacific at Wauwatosa, Wis., died on September 9. Mr. Webb was born on October 11, 1891. He was a graduate of Blair Business College, Spokane, Wash., and had attended Oregon State College where he studied economics and mechanical engineering for three years. He entered railroad service as an engine wiper on the Idaho & Washington, now the C. M. St. P. & P., in 1908. He became a fireman on the



R. G. Webb

Milwaukee later in 1908; traveling fireman in 1910; engineman in 1911. He served in World War I in 1917-18 and then returned to the Milwaukee as an engineman. He was mechanical expert for the Westinghouse Air Brake Company at St. Paul, Minn., from 1922 until 1924. He again returned to the Milwaukee in 1924 as an engineman. He was appointed traveling engineer in 1929; trainmaster in 1936; assistant superintendent in 1940, and superintendent air brakes at Wauwatosa in 1941. Mr. Webb was a member of the A.A.R., Mechanical Division, Committee on Brakes and Brake Equipment; the Western Railway Club, and the Central Air Brake Club, of which he was chairman.

NEW DEVICES

(Continued)

ing with separate die for each size permits hobbing or machining dies for each size pipe.

Its motor is full ½ hp., heavy duty, 115 volt universal type for d.c. or a.c. operation on any frequency.

Regular equipment includes complete machine, six quick-opening die heads with ½ to 2 in. right-hand dies, bushings, chuck wrench, cable with connectors and cutting oil.

Car Wheel Boring Tool

Micrometer expansion car-wheel boring tools equipped with blades of solid tungsten carbide are now offered by the Davis Boring Tool Div., Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.

Application of solid carbide cutters offers advantages for boring both cast iron and steel car blades. Four cutters are used in rough boring, two in finish boring and a single cutter for chamfering. With the carbide cutters, tests show that wheel boring time is reduced from 15 to 3 min. where high speed steel alloy or steel cutters are used.

The body of the tool is made of chrome nickel steel and is precision machined throughout. Cutter slots are held to tolerances within 0.001 in. Cutter blades are then ground to a 0.0005 in. fit in the holders to assure full bearing contact.

Adjustment of cutters to required bore size is easily made. Through a graduated main screw operating an expanding wedge, cutter movement is controlled within 0.001 in. As much as 1⅛ in. diametrical adjustment is possible. Thus, a wide range of bore diameters is obtainable with each size boring tool.

The structure of the tool does not limit its application to car wheels alone. With slight modification, gear hubs, sprockets, bearings, pillow blocks, heavy sleeves, bushings and collars can be bored with maximum accuracy and speed.

For Economical, Efficient Oil Heat . . .

JOHNSTON
PROPORTIONING
REVERSE BLAST
OIL BURNER

Designed to fill the demand for a simplified oil burner that can be manually or automatically controlled by one lever. The standard Johnston Reverse Blast Oil Burner is equipped with Johnston Fueltrol Proportioning Valve and synchronizing mechanism so that the air and oil balance is maintained in the same ratio at any setting between low and high fire. This burner is a compact unit and is shipped ready for mounting on your furnace. For use with fuel oils.

Write for Bulletin R-508.

BURNERS • BLOWERS • FURNACES • RIVET FORGES • FIRE LIGHTERS • TIRE HEATERS, ETC.

SAFETY THE JOHNSTON LINE DEPENDABILITY

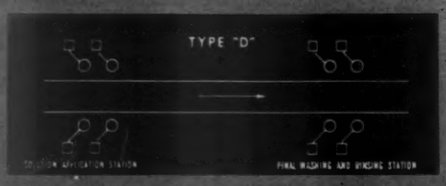
JOHNSTON MANUFACTURING CO.
2825 EAST HENNEPIN AVE.
MINNEAPOLIS 13, MINN.

ENGINEERS & MANUFACTURERS OF INDUSTRIAL HEATING EQUIPMENT

"PUSH BUTTON" WASHING
with a WHITING TRAIN WASHER

Photo courtesy Southern Pacific Railroad

A Whiting Washer control panel located in elevated control house between solution station and washing rinsing station. Engineered for compactness and efficiency and gives operator perfect view of every operation.



The Southern Pacific Railroad uses a Type "D" Whiting Train Washer. It includes a 4-brush solution application station and a 4-brush washing and rinsing station.

WITH a Whiting Train Washer, complete trains, locomotives and all, can be washed at speeds up to 80 feet a minute while one man operates washer controls.

Some roads are washing over 200 cars a day without the involved lay-up time caused by slow, expensive hand-washing crews. Because of controlled operation, the Whiting Train Washer helps to preserve the glistening beauty of original finishes. It also prevents damp yards due to water excesses.

Single- and multiple-washer installations are engineered to meet your specifications for handling coaches, tenders, and Diesel locomotives. Retractable roof brushes may be added easily to any existing installation; thus, a complete train, locomotive and all, can be run through the Whiting Washer at the end of a run. Write for Bulletin CW-C-409 for more information.

WHITING
CORPORATION

15609 Lathrop Avenue, Harvey, Illinois

RAILROAD MAINTENANCE EQUIPMENT

Offices in Chicago, Cincinnati, Detroit, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, and St. Louis. Representatives in other principal cities. Canadian Subsidiary: Whiting Corporation (Canada) Ltd., Toronto, Ontario. Export Department: 30 Church Street, New York 7, N. Y.